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AN ANALYSIS OF STOCK DENSITIES AND HARVEST OF THE CUTTHROAT TROUT OF THE SNAKE RIVER, TETON COUNTY, WYOMING

by

John W. Kiefling

A Thesis

Submitted to the Department

of Zoology and to the Graduate

School of the University of Wyoming

In Partial Fulfillment of the Requirements for the

Degree of Master of Science

University of Wyoming

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ABSTRACT

Kiefling, John W., An Analysis of Stock Densities and Harvest of the Cutthroat Trout of the Snake River, Teton County, Wyoming. M. S. Thesis, Zoology, 1972.

An intensive creel census and marking program was conducted in 1969 and 1970 to make possible population estimates and estimates of harvest of cutthroat trout in the Snake River in Teton County, Wyoming. Stock density determinations made in one of the five study areas provided an estimate of 400 and 992 cutthroat trout, eight inches or more in length, per mile of stream in 1969 and 1970 respectively.

Harvest data provide an estimate of 5,207 and 5,903 cutthroat trout harvested in 1969 and 1970 respectively. The harvest estimates obtained in this study are not comparable to those made in 1967 and 1968 due to a difference in the methods used in obtaining these data.

The catches of cutthroat trout per hour in 1969 and 1970 were calculated to be 0.31 and 0.30 respectively. These relatively low success rates are coincident with the fluctuating volume flows of the Snake River.

Average lengths, condition factors, and catch per unit effort do not indicate significant changes in the fishery from past years.

The population estimates and harvest data, coupled with volume flow information, indicate that production of the fishery is density-independent in nature, and strongly influenced by volume flow.

ACKNOWLEDGMENTS

I would like to extend my appreciation to Dr. George Baxter, and Dr. Lyman McDonald, University of Wyoming, for their assistance during this study. Special thanks are also due Mr. Fred Elserman, Fisheries Management and Research Coordinator, and Mr. Max Rollefson and Mr. Jon Erickson, Fisheries Biologists, for their assistance and suggestions during the course of the research. I also wish to extend my appreciation to the National Park Service for their help in data collection from the portion of the river within Grand Teton National Park.

I am most appreciative of the help and encouragement I have received from my wife during the collection and preparation of this report.

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INTRODUCTION

On the western slope of the Continental Divide in Wyoming, the Snake River is one of the major headwater rivers of the Columbia River Drainage. The Snake River arises in Yellowstone National Park and drains an area of approximately 3,465 square miles in Wyoming (U. S. Geological Survey, 1961). From its origin in southern Yellowstone National Park, this river system drains the Teton Range, the Salt River Range, and portions of the western slope of the Wind River Range. The principal tributaries to the Snake River in Wyoming are the Buffalo Fork, the Gros Ventre River, the Hoback River, and the Greys River. From its point of origin, the Snake River flows southwesterly for a distance of 40 miles into Jackson Lake in Grand Teton National Park. It then continues southerly for some 80 miles where it flows into Palisades Reservoir near the Wyoming-Idaho state line (Figure 1).

The cutthroat trout, Salmo clarki Richardson, is native to the Snake River drainage area. Although Simon (1946) considered the Snake River cutthroat to be a variety of the Yellowstone cutthroat (Salmo clarki lewisi), Baxter and Simon (1970) believed this fine-spotted variety to be worthy of recognition as a distinct variety. The Snake

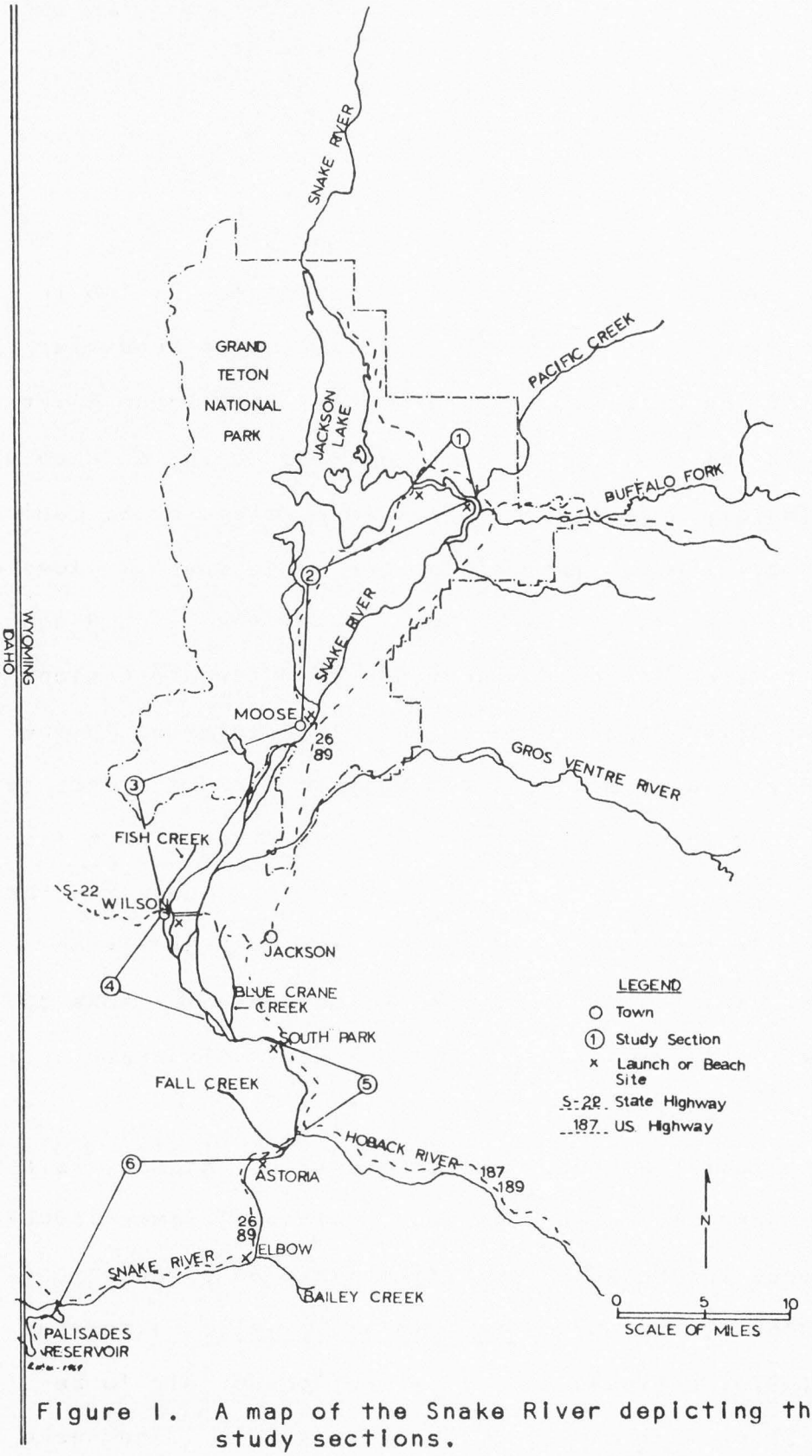

Figure 1. A map of the Snake River depicting the study sections.

River cutthroat is well adapted to the large swift stream habitat, and presently is maintaining itself by natural reproduction in the Wyoming portion of the Snake River (Baxter and Simon, 1970).

The Snake River is presently supporting a good cutthroat trout fishery despite ever increasing angling pressure. In the light of this increase in fishing pressure and the continued loss of river habitat (due to siltation of spawning sites and development of flood control structures), the Wyoming Game and Fish Commission initiated a long-term program of intensive studies on the ecology of the Snake River cutthroat trout in 1964. The first segment dealt with the various aspects of natural reproduction (Hayden, 1968), and subsequent segments have been concerned with the harvest of cutthroat trout (Wiley, 1969), age and growth (Hagenbuck, 1970), and food studies (still in progress).

This, the fifth segment in the series of comprehensive studies dealing with the ecology of the Snake River cutthroat trout, has been given the objective of determining the stock density and age-size structure in the Snake River proper and continuing the analysis of harvest. Before up-to-date management policies can be established, there is a need to determine the stock density of catchable fish and the proportion of the stock that is being harvested annually. This segment was initiated in 1969, and continued in 1970.

It was partially financed by Dingell-Johnson Federal Aid to Fish Restoration funds, Public Law 681, under project F-37-R-5, administered by the Wyoming Game and Fish Commission.

DESCRIPTION OF THE STUDY SECTIONS

The second segment of this long-range study was conducted by Wiley (1969), and involved a comprehensive programmed creel census made on an 80 mile section of the Snake River extending from Jackson Lake Dam to Palisades Reservoir (Figure 1). Wiley (1969) subdivided the 80 miles into six study sections. Subdivision into study sections was based upon a consideration of access in each section to both bank and boat fishermen. A study section generally required approximately a one day float to effectively fish the area, and each section can be censused efficiently.

For this new segment of the study the creel census estimated the harvest on only five of the study sections used by Wiley (Figure 1), covering approximately 59.3 miles of the river.

Section 1. Jackson Lake Dam to Pacific Creek. The river in this section is approximately 4.3 miles long and consists of a single-channel flow with little or no braiding (Figure 1). This section of the Snake River is subject to seasonal discharges from Jackson Lake. As the records from the guaging

station at Moran, Wyoming, indicate (Table 1), variations in discharge are extreme, varying almost 100 fold in the period 1966 to 1970. Due to the extreme fluctuations in river flow, the ecology of this section is very unstable. The lack of the environmental stability of Section 1 results from large fluctuations in volume flows, the secondary effects of high volume flows on the river bottom and the characteristics of low-level discharge (Makenthum and Ingram, 1967).

Fisherman access in Section 1 is restricted to access areas maintained by the National Park Service. In Section 1, areas which receive the greatest angling pressure are the spillway below Jackson Lake Dam, the Cattleman's Bridge, and near the mouth of Pacific Creek.

This study section, of moderate gradient, is also floated by fishermen and sightseers who may launch immediately below Jackson Lake Dam and beach their craft at the mouth of Pacific Creek.

Section 2. Pacific Creek to Moose. This section of the river flows through Grand Teton National Park for some 19.5 miles. Section 2 is of low gradient, moderately braided with small channels, has many pools, and receives the waters of the Buffalo Fork River, the only major tributary in this section (Figure 1).

Table I. Volume flow in cubic feet per second of the Snake River at Moran, Wyoming, 1964-1970.*

Month	1964	1965	1966	1967	1968	1969	1970
J	104	711	531	383	431	412	392
F	415	1,496	519	392	427	445	397
M	411	1,750	480	387	418	442	---
A	404	2,430	1,121	775	421	2,279	673
M	2,316	2,660	2,323	2,228	1,399	2,458	2,470
J	4,098	2,629	3,018	2,915	3,720	2,500	4,410
J	3,532	3,008	2,669	3,374	2,753	2,758	3,061
A	3,350	3,284	2,652	3,470	3,281	5,401	2,690
S	1,230	2,036	2,564	1,870	2,283	2,348	2,631
O	880	421	285	1,093	74	55	694
N	299	428	47	286	397	93	416
D	96	422	84	383	398	384	428
Mean	1,428	1,773	1,358	1,463	1,334	1,624	1,660

*United States Geological Survey

The National Park Service restricts fisherman access in this section to those areas which are maintained by the Park Service. Those areas from which boats may be launched and beached, as well as those sites to which shore fishermen have access, are marked by signs.

Section 3. Moose to Wilson Bridge. A portion of the upper part of Section 3 lies partly within the boundaries of Grand Teton National Park, while the lower portion of this section

flows through privately owned properties. This study section is 14.5 miles long, with some nine miles of the west bank and approximately six miles of the east bank being contained by levees constructed by the U. S. Army Corp of Engineers. The levee areas of this section are located immediately upstream from the highway bridge near the town of Wilson.

The major tributary in Section 3 is the Gros Ventre River which flows into the Snake River from the east (Figure 1). Hayden (1968) noted the importance of Bar B C Spring Creek, a tributary to the Gros Ventre, as a spawning site. Bar B C Spring Creek flows westward from its spring origin and enters the Gros Ventre about one-half mile above its confluence with the Snake River.

In this study section, pools and swift deep runs are common. The section is also characterized by some braiding into small to moderate sized channels, and a moderate gradient.

Fisherman access is good for shore anglers in the downstream end of this study area. Levee maintenance roads leading from State Highway 22 provide access for the bank fishermen. Another 5.3 miles of the river is accessible to those bank fishermen who obtain permission to fish on private property.

Commercial and private float fishermen use this section regularly. Boats are usually launched at Moose and beached

at or just above the State Highway 22 bridge near the town of Wilson, Wyoming (Figure 1).

Section 4. Wilson Bridge to South Park Feedground. Section 4 is about 10 miles long and is contained by levees on the west bank for the uppermost 3.5 miles. This is, perhaps, the most physically unstable study section, with channel changes occurring annually. The gradient is moderate, with many channels in the braided sections partially choked by fallen trees and debris.

The most important tributaries in this area are Fish Creek, Spring Creek, and Blue Crane Creek. Hayden (1968) found these tributaries to be important spawning and nursery streams.

Public access areas in this section are maintained by the Wyoming Game and Fish Commission. Three such public fishing access areas are available to bank fishermen, and include the levee portion of the upstream end, the Taylor Creek access area, and the South Park Feedground area. Local landowners restrict access to a major portion of this section.

Float fishing is very popular in this section of the river. Boats may be launched at the State Highway 22 bridge near Wilson, and beached at the South Park Feedground near the U. S. Highway 26-29 bridge.

Section 5. South Park Feedground to Astoria Hot Springs. This section of river is 11 miles long and characterized by deep runs and large pools. The gradient is moderate, with little or no braiding.

Tributaries to the Snake River in Section 5 are Fall Creek, Flat Creek, and the Hoback River.

This portion of the study area parallels U. S. Highway 26-89, which provides bank anglers with some access to the river. However, fishing in such areas along the highway is restricted both by landowners and by the steep, narrow canyon walls of this upper portion of the Grand Canyon of the Snake River. Float fishing is also popular in this area with launching and beaching sites readily available. Most of the float trips begin at the U. S. Highway 26-89 bridge, and terminate near Astoria Hot Springs.

METHODS

Creel Census. In 1969, a programmed creel census which was reduced somewhat from the census in 1968 (Wiley, 1969) was put into effect. This creel census program was designed to estimate the magnitude of Snake River cutthroat trout harvest as well as the return of marked fish to the creel, for the purpose of making a population estimate.

The 1969 creel census was reduced, in comparison with 1967 and 1968, to enable a single census taker to make a limited, but statistically accurate census. The object of

such a reduction was to give remaining project personnel time to participate in the marking program (to be discussed later).

The fishing season on the Snake River opened April 1, and closed on October 31 in both 1969 and 1970. The programmed creel census was designed by the Department of Statistics, University of Wyoming and was stratified in the following manner:

(1) By area: the five study sections (described previously).

(2) By month: All months from April through October (except June).

(3) By type of fisherman: bank or boat fisherman.

Most creel census programs utilized today are stratified in nature (Carlander, et. al., 1958, and Murphy, 1966).

Sampling was confined to one six-hour period, (1200-1800 hours). Previous census programs (Wiley, 1969), had indicated that only 1.56 percent of the thru-fisherman contacts were made before 1200 hours, so no census periods were scheduled before this hour.

Bank and boat fishermen were censused separately, but the census periods (1200-1800 hours) were the same. Boat fishermen contacts were made at established landing sites.

When the 1969 census was designed, it was anticipated that certain information relative to time periods not to be

sampled in the 1969 census could be extrapolated from similar information obtained in 1967 and 1968. In the analysis of the data finally obtained in 1969 and 1970, it was decided that such extrapolations would not be valid.

The Statistics Department of the University of Wyoming also suggested that eight airplane counts be made per month in 1969. These flights were scheduled to be flown twice daily on predetermined census days. The airplane counts were necessary for instantaneous counts of fishermen and to provide a check on the accuracy of the ground count estimates. Due to previous scheduling of Wyoming Game and Fish Commission planes, all of the airplane counts were deleted. Again, department and project personnel believed that the check-on-the-ground counts could be extrapolated from previous years' information.

The generalized census program for 1969 and 1970 was then completed in this manner:

(1) April and May. Interviews of bank fishermen were made four times per month during the 1200-1800 time period in each of the five areas. Interviews of boat fishermen were made four times per month during the 1200-1800 time period in each of the five areas.

(2) June. No census periods were scheduled during June because almost no fishing occurs

during the period of high water, however, the Park Service did conduct a randomized census in Section I during this month.

(3) July through October. Interviews were scheduled as for April and May.

In 1969, the randomized programmed creel census as designed by the Department of Statistics, University of Wyoming (Appendix 1), was conducted in the five study sections. One hundred and seventy four half-days were sampled in 1969; 83 percent of the days sampled were week days and 17 percent were weekend days (Table 2). Wiley (1969) concluded that there was little difference in fishing pressure between week days and weekend days due to the nature of fisherman-use in Jackson Hole.

Bank and boat interview data were recorded on separate forms (Appendix 2).

Information obtained from fisherman interviews included the following:

(1) Numbers of individuals fishing.

(2) Numbers of hours fished, separated into thru and not-thru hours.

(3) Total hours fished.

(4) Total hours fished from the bank by boat anglers.

(5) Species and numbers of fish harvested.

(6) Method of harvest (bait, flies, hardware).

Table 2. Numbers of days censused by study sections, Snake River, 1969.

Bank

Section	Total No. Days	Week Days	Weekend Days
I	25	22	3
II	18	17	1
III	14	12	2
IV	16	13	3
V	18	14	4
Totals	91	78	13

Boat

Section	Total No. Days	Week Days	Weekend Days
I	20	14	6
II	17	14	3
III	17	11	6
IV	15	14	1
V	14	13	2
Totals	83	66	18

Information obtained pertaining to the total hours fished from the bank by boat anglers is questionable. Most of the boat fishermen interviewed were unsure of the exact number of hours fished from shore and made guesses. For this reason,

boat fishing hours represent both bank and boat-hours fished.

In 1970, the census was expanded in an effort to obtain a better estimate of the return of marked cutthroat trout to the creel. While the data collected and the methods remained the same, the number of sample periods was increased (Appendix 3). Such an expansion meant that each study section was censused nine days per boat fisherman, and nine days per bank fisherman from June through October. Sections 1 and 2 were not expanded for the months of April and May due to light fishing pressure and lack of manpower to conduct the census at that time. Sections 1 and 2 are nearly inaccessible because of snow conditions in April and May. For these reasons, both bank and boat fishermen were censused only four days in each section during April and May. Sample periods were scheduled for the month of June in all sections of the river in case water conditions would permit a census.

During the 1970 census, 277 days were sampled in all areas (Table 3). A total of 180 week days were sampled in 1970 which represented some 65 percent of the days sampled. The 97 weekend days represented 35 percent of the total days sampled during the 1970 programmed creel census.

Table 3. Numbers of days censused by study section, Snake River, 1970.

Bank Fishermen

Section	Total No. Days	Week Days	Weekend Days
I	24	14	10
II	11	8	3
III	34	21	13
IV	35	25	10
V	31	21	10
Totals	135	89	46

Boat Fishermen

Section	Total No. Days	Week Days	Weekend Days
I	20	12	8
II	15	9	6
III	35	22	13
IV	36	22	14
V	36	26	10
Totals	142	91	51

As in previous years (Wiley, 1969), five sections of the river were censused in accordance with the census schedule approved by the Department of Statistics, University of Wyoming (Appendices 1 and 2). This resulted in at least

one, and as many as three, sections being censused on a given day. An example of such scheduling is as follows:

July 4, 1970--Area 4 - Boat
Area 5 - Bank
July 5, 1970--Area 3 - Bank
Area 3 - Boat
Area 4 - Boat
July 6, 1970--Area 5 - Bank

Harvest. Appendix 4 summarizes the raw data for each section and each month. From summary sheets the following information could be extracted:

(1) Sample period dates.
(2) Numbers of week days and weekend days sampled.
(3) Numbers of fishermen interviewed.
(4) Total fisherman hours.
(5) Through-fisherman hours.
(6) Not-through-fisherman hours.
(7) Snake River cutthroat trout harvested (by through- and not-through fishermen).
(8) Marked cutthroat trout returned to the creel.
(9) Harvest methods employed by fishermen.
(10) Number of resident fishermen.
(11) Resident catch statistics.
(12) Number of non-resident fishermen.
(13) Non-resident catch statistics.

(14) Number of non-trout species harvested.

(15) Harvest of trout other than cutthroat.

From the data depicted in Appendix 5, estimates of numbers of fishermen, fisherman hours, and total harvest information was expanded by the methods outlined by Cochran (1963) for stratified sampling. The stratification of these data provided a means of determining confidence limits (Cochran, 1963). Appendix 4 is an example of the methods employed in calculating harvest estimates and setting confidence limits on these estimates.

The success rate of cutthroat trout per hour was obtained, using the arithmetic mean of the success rates of both through- and not-through fishermen. The total number of cutthroat trout harvested was then divided by the total estimated hours fished by both through- and not-through fishermen in order to obtain an estimate of the catch of cutthroat trout per hour.

Marking. Fin clipping is probably the most common marking technique used in inland fisheries, and is an easy operation to carry out. In most cases, regeneration of fins is common, but the regenerated fins are usually not difficult to identify. When marking to distinguish different lots of fish, the clipping of a specific fin is probably the best method (Scott, 1968).

Marking was conducted during the fishing season, with marking and harvest occurring simultaneously. Due to high water and the low conductivity of the Snake River, which made electro-fishing impracticable, a decision was made to collect the cutthroat trout for marking by hook and line. The objective was to mark at least 1,000 cutthroat trout during 1969, and if possible to recapture the marked fish using the electro-fishing methods developed by the Montana Fish and Game Department during the month of October when Jackson Lake Dam is shut down for repairs (Vincent, 1969). Such a program called for the cutthroat trout to be marked and released in the area of their capture to insure a random distribution of marked fish. Marking in 1969 would take place in Sections 2, 4, and 5 (Figure 1). Avon rubber rafts were used to float study sections 4 and 5 during the marking project.

The National Park Service was responsible for the marking program in Section 2. In 1969, Park Service personnel contacted guides and other interested parties to do this marking. In that year cutthroat trout were marked for identification by removing the adipose fin. Stauffer and Hansen (1969), also Horak (1969), found no significant effects on survival or growth due to fin clipping. A total of 591 cutthroat trout were marked in Section 2 during the summer of 1969, and 6 were returned to the creels checked.

Unfortunately, length measurements were not taken by the personnel involved in this phase of the study.

An intensive marking program was undertaken by Wyoming Game and Fish Commission personnel in Section 4 and 5 between July 1, 1969, and August 26, 1969. Since Section 4 was considered to support a better fishery, more effort was expended in marking fish in this section.

In 1969 each cutthroat trout marked in these areas was measured to the nearest tenth of an inch and released after removal of the left pelvic fin. A total of 687 cutthroat trout was marked in Sections 3 and 4 (Table 4). Figure 2 depicts the percentage of each size class of those cutthroat trout marked in 1969.

Table 4. Total numbers of cutthroat trout marked, by study section, and known mortality, Snake River, 1969.

Section	Cutthroat Trout Marked	Known Mortality Flies	Lures	Total	Percent Mortality
4	538	1	5	6	1.12%
5	149	2	0	2	1.34%
Total	687	3	5	8	2.46%

In order to reduce marking mortality, fish were taken on Number 12 or 14 flies or baitless, treble-hook lures. After a fish was hooked, it was recovered as quickly as possible to avoid tiring, then it was measured, marked and released. Marnell and Hunsaker (1970) noted, "Tiring induced by anglers deliberately 'playing' fish for up to 10 minutes did not increase mortality." As indicated previously in Table 4 immediate mortality due to marking in Section 4 was 1.12 percent, while marking mortality was 1.34 percent in Section 5.

The estimated mortality caused by marking was not substantiated by holding marked fish for a period of time in a live car for a number of reasons. The placement of live cars in the marking sections was impractical due to the large number of persons floating the river and the probability of displacement or vandalism to the live cars and/or its contents. Fluctuating flows during the marking period (4,100 c.f.s. to 7,810 c.f.s., Appendix 6), made placement of live cars in representative sections of capture nearly impossible. The presence of such predators as the American merganser (Mergus merganser americanus), and the river otter (Lutra canadensis), were of major concern. The live cars may have kept the marked fish from physical harm, but the stress induced by probable harassment from these predators could not be avoided.

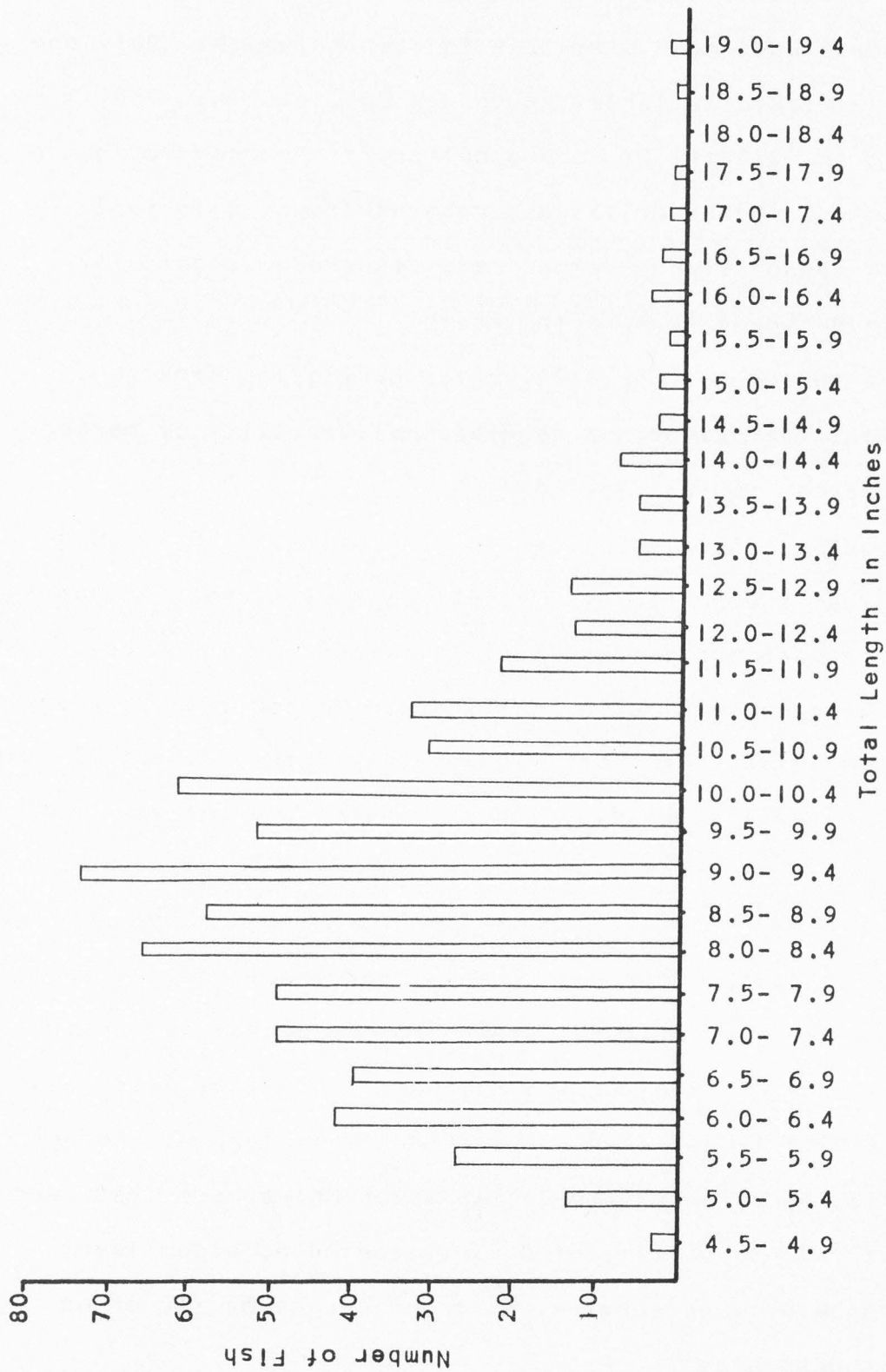

Figure 2. Number of cutthroat trout marked in Sections 4 and 5, by size class, Snake River, 1969.

In 1969 a total of 22 marked cutthroat trout was harvested ranging from 8.5 to 18.9 inches in length. Only one of the 22 marked cutthroat harvested was less than 9.0 inches. In 1970 all 22 marked cutthroat returned to the creel were 9 inches or larger, ranging from 9.0 to 19.2 inches. These returns demonstrate fisherman selectivity for fish 9 inches or more in length.

Due to the low mortality rates during the marking operation, the author has assumed that mortality of marked and unmarked fish was the same.

Studies conducted by Shetter and Allison (1958), suggested that there was not a significant difference in mortality between trout caught with barbed flies and those caught with barbed treble-hook lures. In addition, the same report indicated more specifically that Number 12 artificial flies and small spoon-type lures (as were used on the Snake River), did not cause significant mortality in released trout. Shetter and Allison (1955), reported a mortality of 1.4-3.3 percent for Hunt Creek brook trout and, in 1958, a 2.6 percent mortality of brook trout captured on lures. This last study (Shetter and Allison, 1958) indicated less mortality of trout seven or more inches in length. Research conducted by Stringer (1967), in which Chi-square tests were made at the probability of 0.09 indicated no significant difference between survival of trout caught on fly or on treble-hook lures.

Marnell and Hunsaker (1970), concluded that the survival of marked fish was not measurably affected by water temperatures in the 37° to 62° F. range. Examination of field notes indicates that water temperatures were within this range during the marking period (a surface temperature of 59.9° F. was recorded on August 21, 1969, and August 26, 1969, was the last day of major marking effort).

On October 6, 1969, electro-fishing was implemented in a portion of Section 2, in an effort to mark additional cutthroat trout. If this method had proved successful, an additional population estimate would have been made possible.

Electro-fishing was carried out while floating through predetermined study sections. A fourteen-foot fiberglass flat-bottomed boat was utilized for this purpose. A stationary negative electrode was fastened to the bottom of the shocking boat. The boat also contained a mobile or stationary positive electrode, a portable 1,700 watt AC generator with a rectifying unit to change the alternating current to various forms of direct current, and a live box for captured fish. After their capture, the cutthroat trout were to be measured and fin clipped before their release.

The electro-fishing efforts made in Section 2 on October 6, 7, 8, and 23, 1969, were undertaken after the gates of Jackson Lake Dam were shut down. During the

electro-fishing project, the water temperatures were in the 40° range, and as a result, it is logical to assume that most of the cutthroat trout had become isolated in deeper water. A total of approximately 97,610 feet of river was electro-fished.

The unit proved to be ineffective for taking all fish in the large main-channel pools which were estimated to be over ten feet in depth. Suckers and whitefish were electro-fished in the main-channel pools that were only 5 to 6 feet in depth. A total of only 60 cutthroat trout was collected during the 17 man-day project. Most of the trout taken were 13 to 17 inches in length. Project personnel assumed that larger trout were more susceptible to electro-fishing, while the smaller fish were able to break away from the field. Many times trout were observed breaking away from the electrical field, and observations suggest that the electrode had to be activated almost directly over a trout to be effective. The best success for recovering trout was experienced in two small channels where unit coverage was an estimated 80 percent or more. Those trout collected in the main channel were generally taken one at a time. Due to the ineffectiveness of the electro-fishing operations in taking sufficient numbers of cutthroat trout for making a population estimate, this method was discontinued.

The Snake River exhibited high volume flows in 1970, with flows fluctuating from 19,100 c.f.s. to 1,400 c.f.s. during the fishing season (Appendix 7). Due to these conditions and the resulting poor fishing conditions, the effort expended in marking was reduced. Wyoming Game and Fish Department personnel carried out a reduced marking program in 1970, in which a total of 246 cutthroat trout were marked by removing the right pelvic fin. All marking was conducted in Section 4. A known mortality of four cutthroat trout taken on flies and one taken on a lure occurred for a combined marking mortality of 2.02 percent. The percent of each size class of those cutthroat trout marked in 1970 is depicted in Figure 3.

In 1970, the Park Service was unable to recruit help for marking cutthroat trout in Section 2 and no fish were marked in that section.

Population Estimates. Population estimates in 1969 and 1970 were made only for Section 4 because the marking effort and return of marked fish to the creel during the census periods were mainly in this section. A 95 percent confidence interval was calculated for each of the population estimates (Appendices 8 and 9 respectively).

Population estimates in Section 4 were obtained by the Schnabel method (Ricker, 1958, p. 100). This method is a means of estimating populations by a program of short

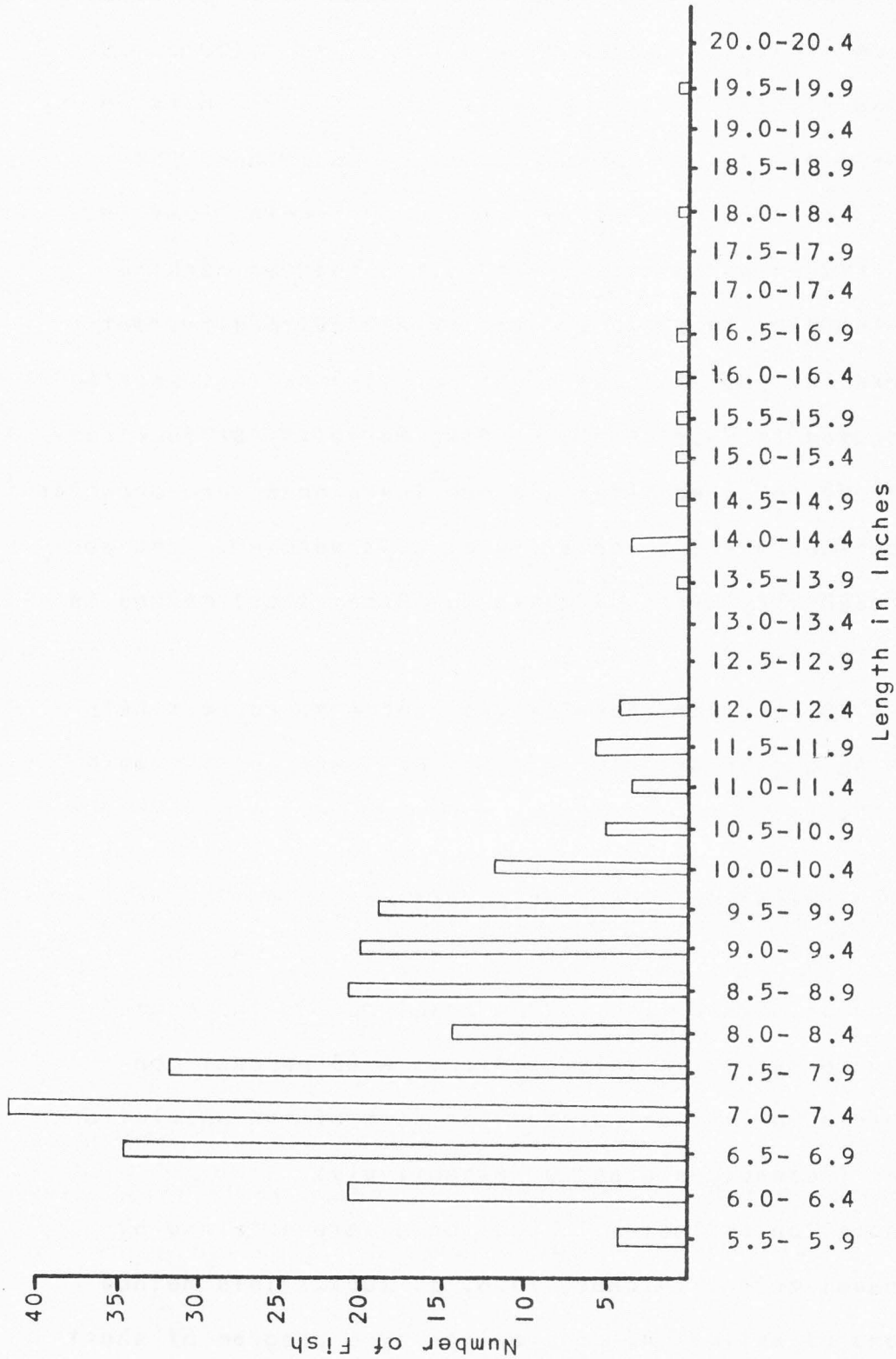

Figure 3. Numbers of cutthroat trout marked in Section 4, by size class, Snake River, 1970.

period simultaneous marking and recovery. Every sample period yields an independent estimate of the size of the population, but the final estimate is derived from the equation:

$$N = \frac{\Sigma (C_t M_t)}{(\Sigma R_t) + 1}$$

Where

C_t= total sample M period t

M_t= number marked at large at beginning of period t

R_t= number of recaptures in sample C_t

This method of fishing and marking simultaneously gives estimates of the population from the proportion of marked fish in the creel by considering the number of marked fish still at large during each sample period.

The Schnabel method depends upon the assumptions that the distribution of marked fish is random, and that the possibility of catching a marked fish is a rare event, so that the recoveries may be treated as a Poisson variable (Ricker, 1958, p. 101). Ricker (1969) notes that Schnabel's method gives estimates which lie between the extremes of population density.

The other assumptions made for the population estimates of 1969 and 1970 are as follows (Ricker, 1958):

(1) Mortality of marked and unmarked fish is the same.

(2) Marked and unmarked fish have the same probability of recapture.

(3) No loss of marks.

(4) All marked fish are recognized and reported on recovery.

(5) There is little or no recruitment or migration of the catchable or selective stock during the census period.

RESULTS

Population Estimates. The data utilized in estimating the cutthroat trout population in Section 4 of the Snake River, were collected during the months of July through October in both 1969 and 1970. The return of marked fish in 1969 and 1970, strongly indicates fisherman selectivity for cutthroat trout which are 9 inches or larger (Figures 4 and 5). Due to such selectivity, only those fish which were 8 inches or larger were considered to be susceptible to harvest, hence the population estimate was for only fish of that size range. Of a total of 538 cutthroat marked in Section 4 in 1969, only 365 cutthroat were 8 inches and larger. The population estimate in Section 4, 1969, was calculated to be 4,002 fish which were 8 inches and larger.

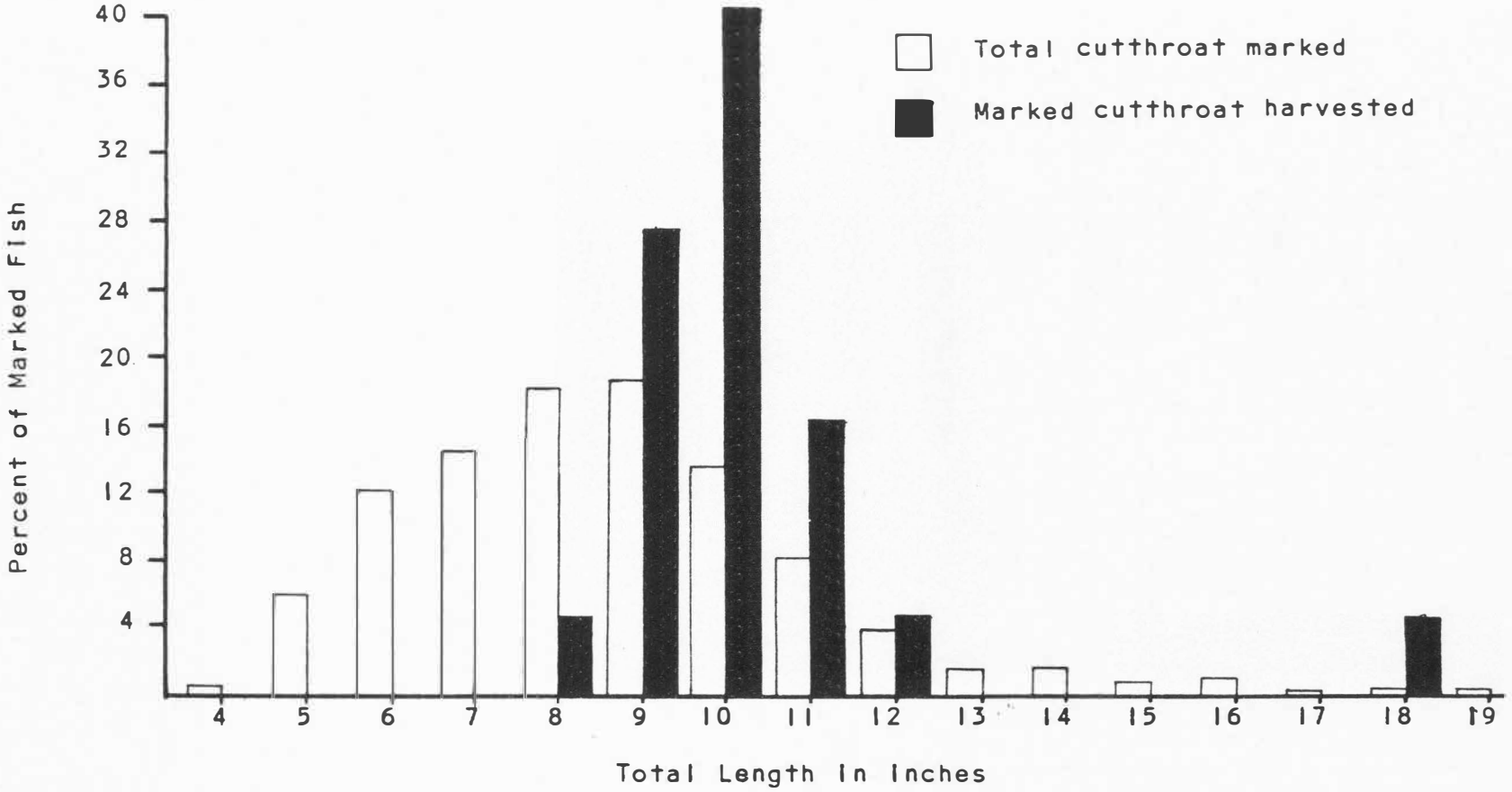

Figure 4. Length frequency of total cutthroat trout marked and cutthroat trout harvested, Snake River, 1969.

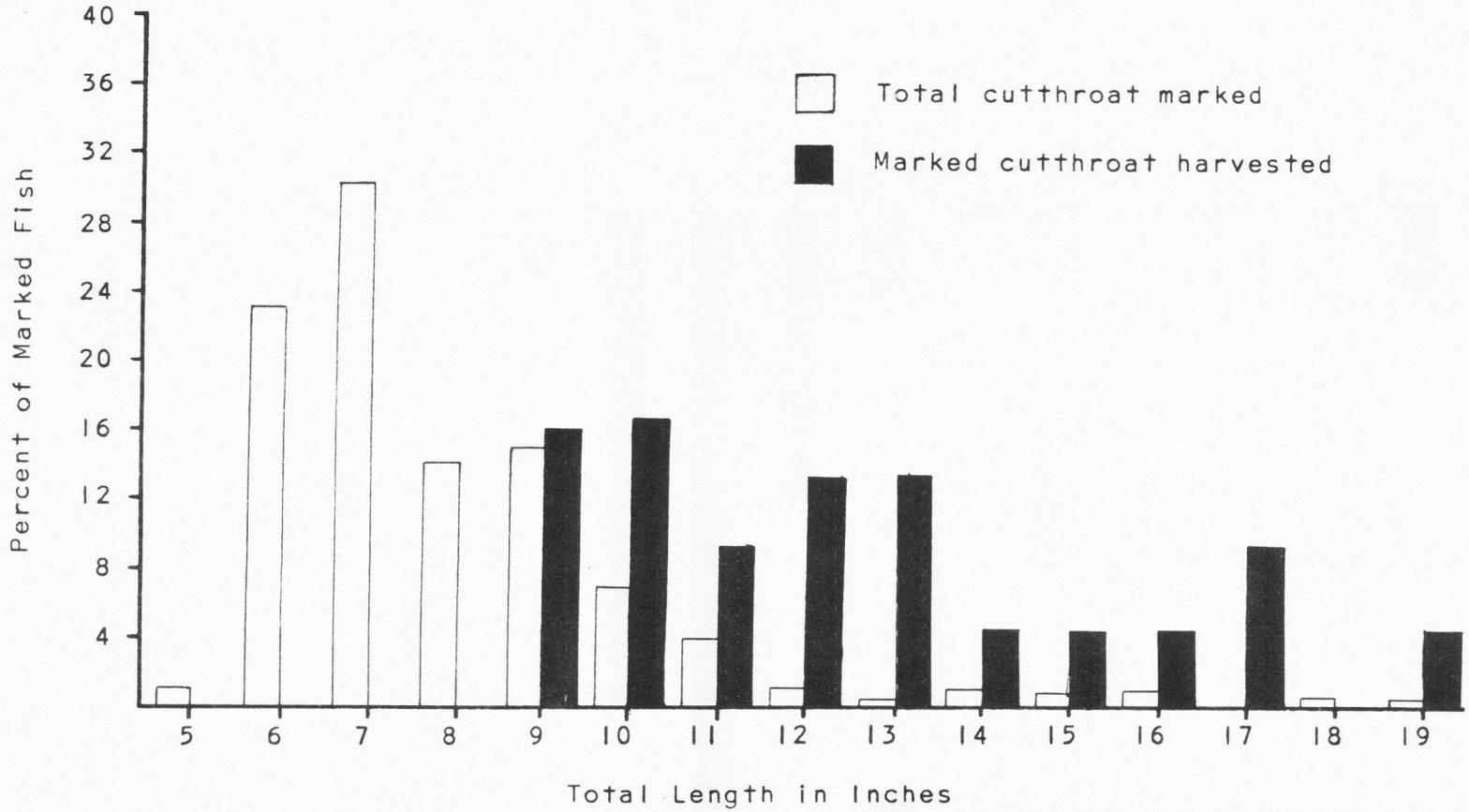

Figure 5. Length frequency of total cutthroat trout marked and cutthroat trout harvested, Snake River, 1970.

A complete summary of the mark and recovery program and the calculations leading to the final estimate are tabulated in Table 5. One different feature of this method is the difference in length of sampling periods. Each sample period represents only those scheduled census days in which cutthroat trout were harvested.

The confidence interval at the 5 percent level of probability was determined by the method described by Rounsefell and Everhart (1953) (p. 92). The lower and upper limits respectively, of the confidence interval at the 5 percent probability level with 19 degrees of freedom, were 2,629, and 8,375 (Appendix 8).

In order to compensate for the mortality of trout marked in 1969 whose return to the creel in 1970 was used in the 1970 population estimate, their rate of survival was estimated from the data of Hagenbuck (1970). These data were used to calculate the total annual mortality as described by Rounsefell and Everhart (1953, Table 7.2). The resulting rate of survival and related mortality rates in 1967 and 1968 are depicted in Tables 6 and 7 respectively. An average rate of survival was calculated as the mean of the annual mortality rates calculated for 1967 and 1968 and was .6587.

The mortality rates calculated from Hagenbuck's data are from the age frequencies in the catch and because of the selectivity for fish over 9 inches in length are subject to

Table 5. Population estimate of Section 4, Snake River, 1969.

Sample Period t	Day Period Began	No. of Days in Period	M_t	C_t	R_t	$M_t \cdot C_t$	$\frac{M_t \cdot C_t}{R_t}$	Cumulative G	Cumulative F	Cumulative Pop. Est. $\frac{I}{J}$
A	B	C	D	E	F	G	H	I	J	K
1	July 1	1	30	19	0	570	0	570	0	0
2	3	2	31	5	0	155	0	725	0	0
3	10	7	112	7	1	784	784	1,509	1	1,509
4	16	6	191	18	0	3,538	0	4,947	1	4,947
5	17	1	191	1	0	191	0	5,138	1	5,138
6	24	7	263	3	0	789	0	5,927	1	5,927
7	Aug. 5	12	271	22	1	5,962	5,962	11,889	2	5,945
8	13	8	273	17	3	4,641	1,547	16,530	5	3,306
9	14	1	270	7	0	1,890	0	18,420	5	3,684
10	16	2	270	5	1	2,200	2,200	20,620	6	3,437
11	21	5	287	22	0	6,314	0	26,934	6	4,489
12	22	1	287	64	3	18,367	6,122	45,301	9	5,033
13	23	1	285	2	0	570	0	45,871	9	5,097
14	Sept. 6	14	314	12	2	3,768	1,884	59,639	11	4,513
15	22	16	328	1	0	328	0	49,967	11	4,542
16	25	3	332	1	1	332	332	50,299	12	4,192
17	Oct. 1	6	345	15	1	5,175	5,175	55,474	13	4,267
18	3	2	350	4	1	1,400	1,400	56,874	14	4,062
19	24	21	351	6	0	2,106	0	58,980	14	4,213
20	26	2	351	3	0	1,053	0	60,033	14	4,288
							$R_t + 1 = 15$			4,002

Table 6. Total annual mortality of the Snake River cutthroat trout, Section 4, 1967. (Data from Hagenbuck, 1970).

A	B	C	D	E	F	G	H
Age	Age Frequency	Logarithm of Age Frequency	Logarithm of f(y) Minus Log f(y-1)	D Times 2.303 or $\frac{1}{\log_{10} e}$	1-D or log s	Antilog of F	D Weighted by f(y)
y	f	log f	log $(\frac{1}{s})$	(y)	log s	s(y)	log $(\frac{1}{s})(w)$
II+	29	1,4624					
III+	19	1.2788	-0.1836	0.4228	0.8164	0.6397	-0.8003
IV+	4	0.6021	-0.6767	1.5584	0.3233	0.2104	-1.3534
V+	1	0.0000	-0.6021	1.3866	0.3979	0.2500	-0.6021
Total			-1.4624		1.5376		-2.7558
Average			-0.4874	1.1226		0.3667	

$\Delta = 1.1226^{*}$
$s = 0.3667^{*}$
$r = 0.6333^{*}$

Total Annual Mortality = 63.3 percent

*Annual Mortality Rate = r = (1-s) = .6333
* Δ = Instantaneous Mortality Rate
*s = Rate of Survival

Table 7. Total annual mortality of the Snake River cutthroat trout, Section 4, 1968. (Data from Hagenbuck, 1970).

A	B	C	D	E	F	G	H
Age	Age Frequency	Logarithm of Age Frequency	Logarithm of f(y) Minus Log f(y-1)	D Times 2.303 or $\frac{1}{\log 10^e}$	1-D or log s	Antilog of F	D Weighted by f(y)
y	f	log f	$\log \left(\frac{1}{s}\right)$	(y)	log s	s(y)	$\log \left(\frac{1}{s}\right)$ (W)
II+	66	1.8195					
III+	42	1.6232	-0.1963	0.4521	0.8037	0.6368	-1.0922
IV+	7	0.8451	-0.7781	1.7920	0.2219	0.1667	-2.0587
V+	3	0.4771	-0.3680	0.8475	0.6320	0.4285	-0.6374
Total			-1.3424		1.6576		-3.7883
Average			-0.4474	1.0315		0.4107	

Δ = 1.0315*
s = 0.4107*
r = 0.5893*

Total Annual Mortality = 68.4 percent

* Annual Mortality Rate = r = (1-s) = .6841
* Δ = Instantaneous Mortality Rate
* s = Rate of Survival

some error. Nevertheless, they were used since they represented the only possible means for correcting for mortality of marked fish during 1969 and 1970.

An estimate of the marked cutthroat harvested in 1969 was determined from the census data by direct proportion, as follows:

$$\frac{N}{n} = \frac{C}{c}$$

Where

N = total number of days in Section 4, 1969

n = number of census days in Section 4, 1969

c = marks recovered in creel census

C = estimated total of marked fish harvested in 1969

$$\frac{123}{32} = \frac{C}{14}$$

$$C = \frac{(123)(14)}{32}$$

$$C = 53$$

Although 173 of the fish marked in 1969 were less than 8 inches in length, their annual growth according to Hagenbuck, was such that all these fish were vulnerable to the 1970 harvest. Of the 538 fish marked, 53 were estimated to have been harvested in 1969 (see harvest estimate, indicated above) and 319 died of natural mortality (r = 0.6587)

leaving 166 marked cutthroat available to exploitation in 1970. In 1970, 246 cutthroat were marked in Section 4 and 113 of these were 8 or more inches in length.

Adding the estimated surviving marked cutthroat (166) from 1969, to those marked in 1970 (113), gives an estimate of 279 marked cutthroat at large in Section 4 in the period in 1970 when the population estimate was made.

Utilizing the methods described previously, the 1970 population estimate was calculated to be 9,919 cutthroat in Section 4 which were 8 or more inches in length (Table 8), with a confidence interval at the 5 percent level of probability with 47 degrees of freedom of from 6,535 to 20,575 (Appendix 9).

Although based on the relatively small number of marked fish returns in both 1969 and 1970, the confidence intervals were such that the population estimates here were assumed to be reasonable. The difference between the two years is assumed to be real and resulted from differences in year class strength in the population. The greater confidence interval range of the 1970 population estimate is attributable to an increased harvest without an increase in return of marked fish. Thus, apparently more young, unmarked, fish were available for capture, and the resulting estimate is probably somewhat high.

The density-independent factors of periodic high volume flows (Figure 6), seem to be instrumental in the

Table 8. Population estimate of Section 4, Snake River, 1970.

Sample Period t	Day Period Began	No. of Days in Period	M_t	C_t	R_t	$M_t \cdot C_t$	$\frac{M_t \cdot C_t}{R_t}$	Cumulative G	Cumulative F	Cumulative Pop. Est. $\frac{I}{J}$
A	B	C	D	E	F	G	H	I	J	K
1	July 5	2	166	8	0	1,328	0	1,328	0	0
2	11	6	166	12	1	1,992	1,992	3,320	1	3,320
3	16	5	174	5	0	870	0	4,190	1	4,190
4	17	1	175	22	0	3,850	0	8,040	1	8,040
5	18	1	175	16	0	2,800	0	10,840	1	10,840
6	20	2	175	11	0	1,925	0	12,765	1	12,765
7	22	2	175	40	0	7,000	0	19,765	1	19,765
8	24	2	182	3	0	546	0	20,311	1	20,311
9	25	1	182	23	0	4,186	0	24,497	1	24,497
10	26	1	182	4	0	728	0	25,225	1	25.225
11	29	3	182	3	0	546	0	25,771	1	25.88;
12	Aug. 1	3	184	5	0	920	0	26,691	1	26,691
13	2	1	183	14	1	732	732	27,423	2	13,712
14	3	1	183	5	0	915	0	28,338	2	14,169
15	4	1	183	12	0	2,196	0	30,534	2	15,267
16	9	5	183	21	0	3,843	0	34,377	2	17,189
17	11	2	183	15	0	2,745	0	37,122	2	18,561
18	13	2	186	12	1	2,232	2,232	39,354	3	13,118
19	14	1	186	14	0	2,604	0	41,958	3	13,986
20	15	1	186	25	0	4,650	0	46,608	3	15,536
21	19	4	203	11	1	2,233	2,233	48,841	4	12,210
22	21	2	217	4	0	868	0	49,709	4	12,427
23	23	2	217	22	0	4,774	0	54,483	4	13,621
24	24	1	217	2	0	434	0	54,917	4	13,729

Table 8. (continued)

Sample Period t	Day Period Began	No. of Days in Period	M_t	C_t	R_t	$M_t \cdot C_t$	$\frac{M_t \cdot C_t}{R_t}$	Cumulative G	Cumulative F	Cumulative Pop. Est. $\frac{I}{J}$
A	B	C	D	E	F	G	H	I	J	K
25	Aug. 26	2	218	13	0	2,834	0	57,751	4	14,438
26	29	3	220	2	0	440	0	58,191	4	14,548
27	Sept. 2	4	252	37	1	9,324	9,324	67,515	5	13,503
28	3	1	252	8	0	2,016	0	69,531	5	13,906
29	4	1	269	21	0	5,649	0	75,180	5	15,036
30	5	1	268	5	1	1,340	1,340	76,520	6	12,753
31	6	1	268	19	0	5,092	0	81,612	6	13,602
32	9	3	272	6	1	1,632	1,632	83,244	7	11,892
33	10	1	272	15	0	4,080	0	87,324	7	12,475
34	12	2	270	33	2	8,910	4,455	96,234	9	10,693
35	14	2	270	4	0	1,080	0	97,314	9	10,813
36	17	3	270	22	0	5,940	0	103,254	9	11,473
37	19	2	270	2	0	540	0	103,794	9	11,533
38	25	6	270	1	0	270	0	104,064	9	11,563
39	27	2	270	31	0	8,370	0	112,434	9	12,493
40	28	1	270	7	0	1,890	0	114,324	9	12,703
41	29	1	270	6	0	1,620	0	115,944	9	12,883
42	30	1	270	3	0	810	0	116,754	9	12,973
43	Oct. 2	2	270	8	0	2,160	0	118,914	9	13,213
44	3	1	266	32	4	8,512	2,128	127,426	13	9,802
45	4	1	266	21	0	5,586	0	133,012	13	10,232
46	5	1	266	17	0	4,522	0	137,534	13	10,580
47	16	11	266	4	0	1,064	0	138,598	13	10,661
48	18	2	266	1	0	266	0	138,864	13	10,682
								$R_t + 1 = 14$		9,919

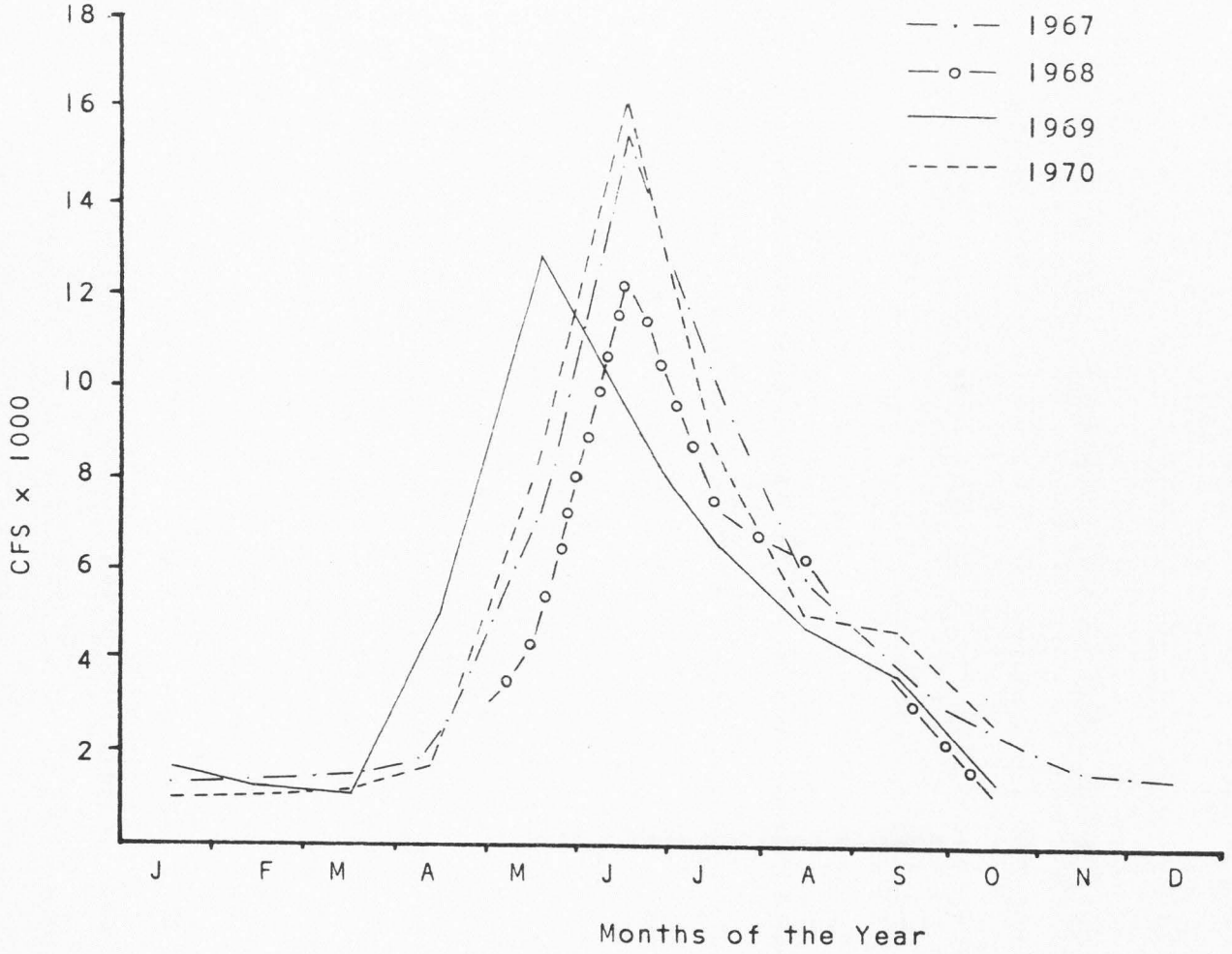

Figure 6. Volume flows of the Snake River measured at gauging station near Alpine, Wyoming, for the year 1967-1970.

determination of population density. High volume flows may exert effects which increase recruitment by increasing the survival of yearling fish and decrease the harvest by causing poor fishing conditions, so that a year of high volume flows can have a very considerable total effect on population numbers.

Harvest. Creel census data in the five study sections of the Snake River provide estimates of 5,207 cutthroat harvested in 1969, and 5,903 in 1970. The examination of preliminary harvest estimates and comparisons with the estimates of Wiley (1969) revealed discrepancies large enough to warrant re-examination of the creel census design in the different years. The differences in the creel census design which caused some of the discrepancies in harvest estimates were: Wiley censused before noon while this census did not; Wiley censused Section 6 and this census did not; Wiley censused Sections 3 through 5 in April and June and this census did not; Wiley's estimates included some trout other than cutthroats.

The 1969 and 1970 harvest estimates were adjusted up by adding an estimated number of fish caught in the morning. To do this, the direct proportion method for expansion of the sample data was necessitated. In 1969, the harvest estimate was 5,144 cutthroat with a range of $\pm$ 8,176 at the 95 percent confidence level (Appendix II).

Expansion of the data by direct proportion resulted in an estimated harvest of 5,207 cutthroat (Appendix 12).

The 1967 and 1968 estimates obtained by Wiley were adjusted to provide estimates comparable to those made in this study by eliminating harvest from Section 6, from Sections 3 through 5 in April through June, and eliminating the trout other than cutthroat recorded by Wiley, 1969, Appendix 7. The adjusted figures are shown in Table 10.

The stratified harvest estimate for 1970 was subdivided into two parts (Appendix 13 and 14). Due to the lack of data collected by National Park Service personnel in Sections 1 and 2, separate estimates, of harvest using a system of stratified sampling, were made for Sections 1 and 2 and 3 through 5 to reduce the variance and also to insure a better harvest estimate for Sections 3 through 5 (Table 9). The non-stratified estimate of the 1970 harvest data resulted in an estimated harvest of 5,903 cutthroat (Appendix 15). The harvest estimate arrived at by the adjustments shown below, and success rates, are shown in Table 10.

Table 9. Stratified harvest estimate of cutthroat trout, 1970.

Sections	Harvest Estimate	Range
1-2	1,453	± 495
3-5	4,444	± 925
1-5	5,897	± 925

Table 10. Summary of Snake River cutthroat trout harvest, 1967 to 1970, (Wiley data adjusted, see text).

Year	River Sections	Estimated Fishermen	Estimated Hours	Estimated Harvest	Success Rate	Water Conditions
1967	1-5	15,988	41,303	10,522	0.26	High
1968	1-5	14,196	37,255	19,578	0.53	Low
1969	1-5	6,887	17,078	5,207* (5,144)**	0.31	Low
1970	1-5	9,483	19,640	5,903* (5,897)**	0.30	High

*Non-stratified estimate of harvest data, (Appendix 12 and 15).

**Stratified estimate of harvest data, (Appendix 11 and 13).

The comparison of the harvest data of 1967 and 1968 with those collected in 1969 and 1970 even after the adjustment of Wiley's estimates is difficult because of the difference in the census methods used. Without instantaneous airplane counts in 1969 and 1970, it was impossible to estimate the number of fishermen not contacted on census days. For this reason, the 1969 and 1970 harvest estimates are known to be somewhat low.

In the Snake River success rates and water conditions seem to be definitely correlated (Table 10). The low success rate in 1967 was undoubtedly due to the shortened fishing season because of the high water, and possible due to heavy exploitation in 1966 which was a low water year (Table 11). The low water conditions of 1968, together with the high water conditions of 1967 may have contributed to the high angling success of that year. We can similarly see the correlation between success rates and stream volume flow in 1970.

Table 11. Surface water records for the Alpine guaging station, Snake River, 1964 through 1970.

Year	July 1	July Mean	Yearly Water Conditions
1964	16,100	11,090	High
1965	13,300	12,690	High
1966	6.990	5,564	Low
1967	17,100	10,790	High
1968	9,800	8,003	Medium
1969	7,430	6,470	Low
1970	13,700	8,595	High

Wiley (1969), attributed the significant harvest increase in 1968 to low water conditions. The harvests in 1969 and 1970, as depicted in Table 12, do not seem to be directly related to flow data, however, these data may be indirectly misleading. The similar success rates of 1967 and 1970 may be the result of the suggested correlation between fishing success and volume flows.

Table 12. Estimated numbers of fishermen and estimated catch of cutthroat trout by study area, Snake River, 1969 and 1970.

1969

	Fishermen		Cutthroat Trout Harvested	
Section	Total	Percent	Total	Percent
1	2,708	39.3	440	8.5
2	1,293	18.8	876	16.8
3	829	12.0	990	19.1
4	1,216	17.7	1,861	35.6
5	841	12.2	1,040	20.0
Totals	6,887	100.0	5,207	100.0

1970

	Fishermen		Cutthroat Trout Harvested	
Section	Total	Percent	Total	Percent
1	4,548	48.0	1,014	17.2
2	487	5.1	540	7.6
3	1,245	13.2	1,143	19.4
4	2,109	22.2	2,174	36.8
5	1,094	11.5	1,122	19.0
Totals	9.483	100.0	5,903	100.0

Harvest by Individual Study Areas. A breakdown of the number of fishermen and estimated catch of cutthroat per acre in 1969 and 1970, indicates a definite variation in harvest between the study sections (Table 13). Wiley (1969), found that such variations existed in 1967 and 1968.

Table 13. Estimated numbers of fishermen and estimated catch of cutthroat trout by study area, Snake River, for the years, 1967 and 1968 and the years 1969 and 1970.

1967 and 1968

	Fishermen		Cutthroat Trout Harvested	
Section	Total	Percent	Total	Percent
1	13,900	41.20	4,344	13.04
2	6,546	19.40	11,306	33.92
3	4,740	14.05	6,849	20.55
4	4,972	14.74	5,814	17.47
5	3,579	10.61	5,015	15.05
Totals	33,737	100.00	33,328	100.00

1969 and 1970

	Fishermen		Cutthroat Trout Harvested	
Section	Total	Percent	Total	Percent
1	7,256	44.32	1,454	13.09
2	1,780	10.98	1,326	11.94
3	2,074	12.67	2,133	19.20
4	3,325	20.31	4,035	36.32
5	1,935	11.82	2,162	19.46
Totals	16,370	100.00	11,110	100.00

The data in Table 12 show that the harvest was greatest in Section 4, even though the fishing pressure was greatest in Section 1. The larger harvest in Section 4 was probably due principally to a greater number of guided float fishermen utilizing this area. The heavier fishing pressure in Section 1 can be attributed to the great number of transient fishermen utilizing the highly accessible area immediately below Jackson Lake Dam where a beautiful view of the nearby Tetons makes this area aesthetically appealing to visitors.

In 1970, it is interesting to note that a reduced harvest was measured in Section 2. The data in Table 13 indicate that Section 2 was formerly a popular area for fishermen (Appendix 16). The reduction in harvest in this area during the 1970 season indicates a drastic change in fisherman use in Section 2 during the last four years. Park Service biologists believe the basic reason for such a change is the large increase in guided scenic float trips in this area. The National Park Service estimated that 40,589 persons floated the Snake River in 1969, and 51,397 persons floated in 1970. As of April 20, 1971, the Park Service indicates that there are 126 commercial scenic float trips scheduled to land at Moose, Wyoming, per day (Section 2). Such great numbers of floaters passing through this fishing area have reached a saturation level which is not tolerated by the float fishermen and bank fishermen. This is possibly

the reason for the increase in fishing pressure in Section 4 (Appendix 17).

The data in Table 13 also indicate very little change in fishing pressure and exploitation in Sections 1, 3, and 5.

Comparing the 1969 and 1970 harvests of cutthroat trout in the five combined study sections with those of Wiley (1969), for 1967 and 1968 we note a sizeable decrease in harvest in 1969 and 1970 (Table 14). These harvest estimates cannot be directly compared due to differences in census techniques.

Table 14. Harvest of cutthroat trout in fish per mile for the Snake River, 1967 through 1970.

Sections	Year	Length of Area in Miles	Harvest Per Mile
1-5	1967	59.3	177
1-5	1968	59.3	330
1-5	1969	59.3	88
1-5	1970	59.3	100

Bank and Boat Fisherman Harvest. Wiley (1969), found that bank fishermen had accounted for 53 percent of the estimated harvest of cutthroat trout in 1967 and 1968.

The 1969 and 1970 data indicate that 63.9 percent of the cutthroat harvest was accounted for by boat fishermen, while bank fishermen caught 36.1 percent of the estimated harvest (Table 15).

Data related to the length of time boat fishermen spent fishing from the boat or from the bank were not analyzed in detail because of a lack of confidence in the information provided by the fishermen interviewed.

Size and Condition of Cutthroat Trout Harvested. Yearly totals of 707 and 1,341 length measurements were obtained from the cutthroat trout creeled in 1969 and 1970, respectively. These measurements ranged from 6.5 to 20.4 inches in 1969, and from 3.0 to 22.4 inches in 1970. The average lengths of cutthroat creeled in 1969 and 1970 were 10.89 and 10.97 inches respectively (Table 16).

Hagenbuck (1970), calculated the average growth histories of creeled fish for six sections of the Snake River as follows: Age I, 4.2; Age II, 7.6; Age III, 11.1; Age IV, 13.9; and Age V, 16.9 inches. A plot of the length-frequency data for cutthroat harvested in Sections 3 through 5, 1969 and 1970, reveals a close correlation with Hagenbuck's (1970) data from fish collected in 1967 and 1968 and the age composition of the 1969 and 1970 harvests (Figure 7). Length-frequency data depicting cutthroat trout harvest in Sections 1 and 2 also shows similarity to Hagenbuck's (1970)

Table 15. Estimated number of boat and bank fishermen and estimated cutthroat harvest by river section, Snake River, 1969 and 1970.

	1969				1970			
Section	Bank Fishermen		Boat Fishermen		Bank Fishermen		Boat Fishermen	
	Fishermen	Harvest	Fishermen	Harvest	Fishermen	Harvest	Fishermen	Harvest
1	2,654	295	54	145	4,358	923	190	91
2	597	223	696	653	243	109	244	341
3	513	311	316	679	818	277	427	866
4	689	386	527	1,475	1,368	560	741	1,614
5	575	470	266	570	732	470	362	652
Totals	5,028	1,685	1,859	3,522	7,519	2,339	1,964	3,564
Percent of Harvest		32.7		67.3		39.5		60.5

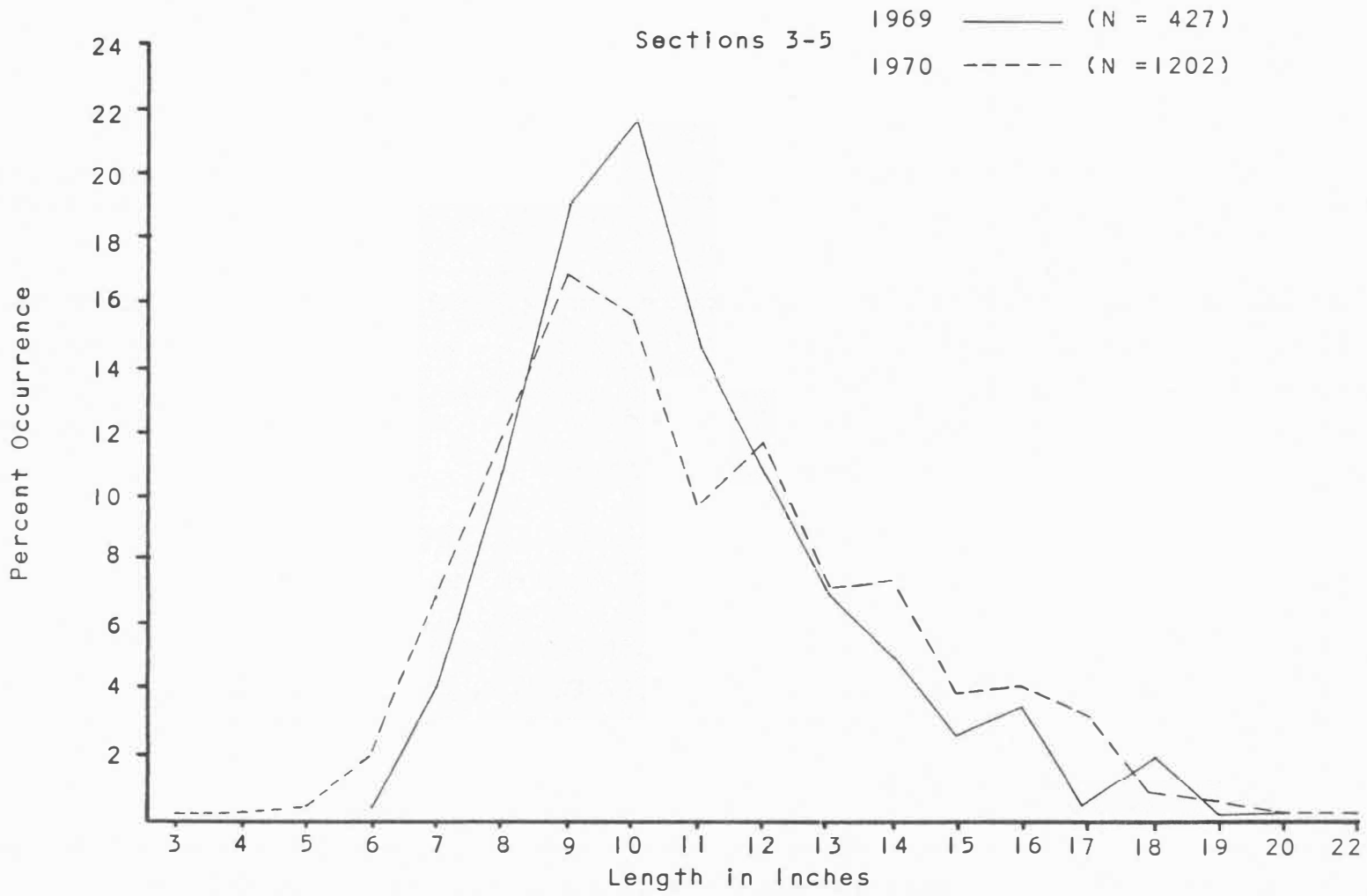

Figure 7. Percent occurrence of size classes of cutthroat trout harvested in Sections 3-5, Snake River, 1969 and 1970.

Table 16. Average length in inches and weight in pounds of the cutthroat harvest, 1969 and 1970.

	1969			1970		
	Sections	Average Length	Average Weight in Pounds	Sections	Average Length	Average Weight in Pounds
	1-2	10.65	0.40	1-2	10.95	0.43
	3-5	11.14		3-5	10.99	0.65
Totals	1-5	10.89		1-5	10.97	0.54

data despite the small size of the samples (Figure 8). Tesch (1968), when referring to the Petersen method of age determination (from length-frequency distribution), notes that modes (Figure 7) are pronounced in fish with short spawning periods and rapid, uniform growth. The large sample of creeled fish collected in 1970 shows this phenomenon quite clearly in the younger age groups, but such modes are not as clear cut in the larger fish due to the overlap in length distribution.

Assuming growth rates similar to those estimated by Hagenbuck (1970), Figure 8 quite clearly shows that the Age II and Age III cutthroat in the Snake River make up a major proportion of the catch.

A comparison of average length-weight data presented by Wiley (1969), shows that the 1969 and 1970 length data are comparable with past years (Table 17).

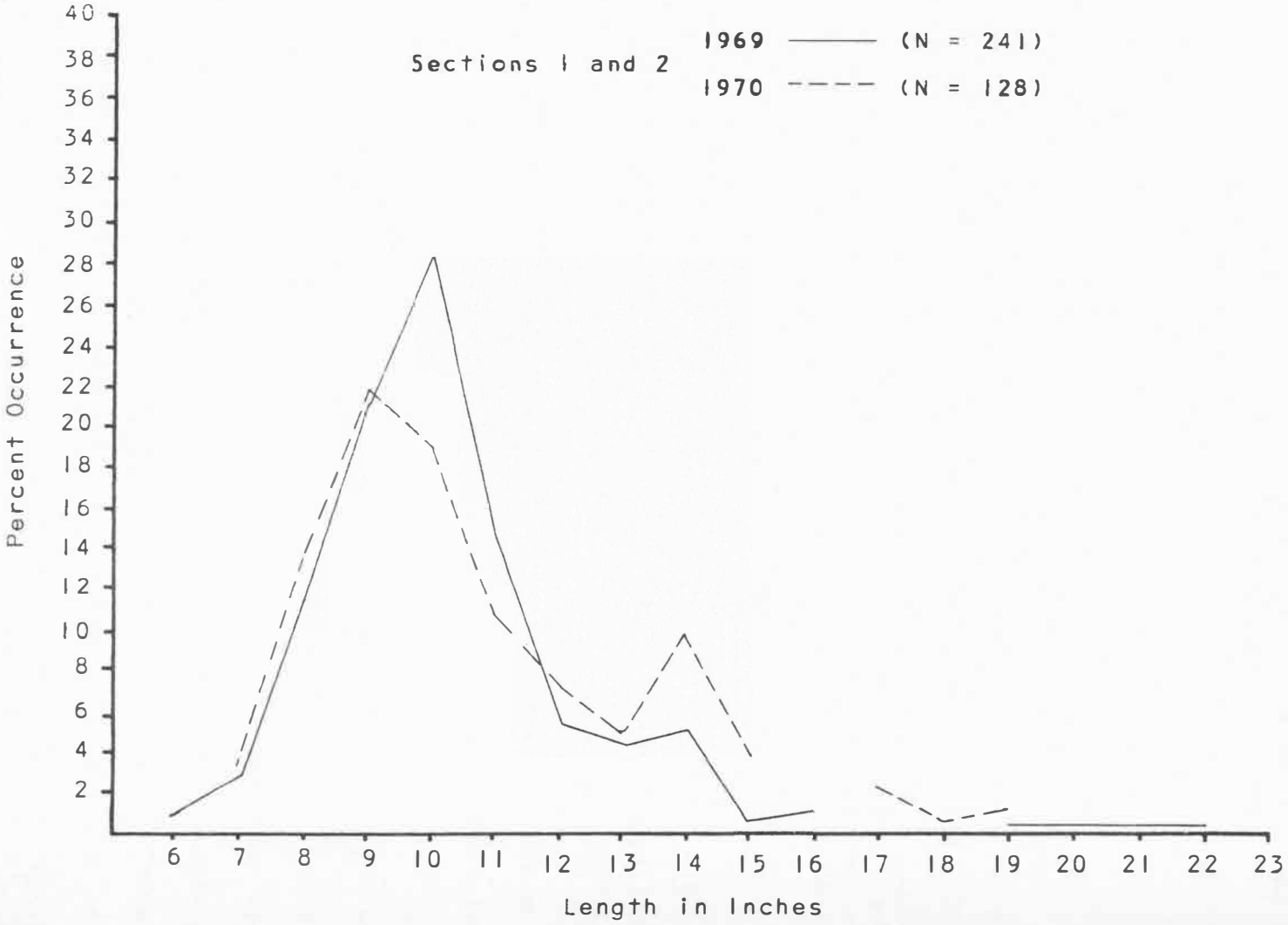

Figure 8. Percent occurrence of size classes of cutthroat trout harvested in Sections 1 and 2, Snake River, 1969 and 1970.

Table 17. Lengths and weights of creeled cutthroat trout from the Snake River, 1955 to 1970.

Year	Sections	Sample Size	Averate Total Length (inches)	Average Weight (in pounds)
1955	2 and 3	207	11.0	0.65
1967	2 and 3	303	10.5	0.89
1968	2 and 3	401	11.2	0.96
1959	5 and 6	286	11.7	0.67
1960	5 and 6	558	11.2	---
1961	5 and 6	276	11.2	---
1967	5 and 6	195	11.9	0.72
1968	5 and 6	584	12.1	0.72
1967	1-6	702	11.0	0.62
1968	1-6	1,333	11.6	0.67
1969	1-5	707	10.9	---
1970	1-5	1,330	11.0	0.54

The coefficient of condition, or C factor, is a commonly used measure of fish plumpness. The C factor formula is:

$$C = \frac{100,000W}{L^3}$$

where W = measured weight in pounds

L = measured total length in inches

Condition factor determinations were made from the nomograph developed by Phenicie and Bishop (1950). The average condition factor for cutthroat trout in 1970 was 33.8. This is somewhat lower than past recorded condition factors, due to the low condition factors of fish harvested in Sections 1

and 2 (Table 18). As was also noted by Wiley (1969), in 1967 and 1968, a lower condition factor, 27.9 in 1969, and 29.8 in 1970, was detected in Section 1 and is attributed to the difference in stream ecology from the other areas in question.

Table 18. Average condition factor (C) and range of the Snake River cutthroat trout for the years indicated.

Year	Section	Average C	Range
1955*	2 and 3	37.9	29-52
1967	2 and 3	35.4	21-61
1968	2 and 3	35.2	21-43
1959*	5 and 6	43.0	33-55
1960*	5 and 6	36.0	31-45
1967	5 and 6	35.4	28-49
1968	5 and 6	35.6	29-47
1967	1-6	35.7	20-78
1968	1-6	35.4	12-75
1969	1 and 2	30.6	18-66
1970	1 and 2	30.3	17-55
1970	3-5	37.3	27-62
1970	1-5	33.8	17-62

*Data from the files of Fisheries Management Crew No. 1, Jackson, Wyoming.

Cutthroat Harvest Success Rate. In 1969 and 1970, the success rate, measured in cutthroat per hour was 0.31 and 0.30 respectively for Sections 1 through 5 (Table 19). These success rates are somewhat lower than those reported by

Table 19. Summary of success rates in cutthroat per hour for the study sections, Snake River, 1967 to 1970.

	1967			1968		
Section	Bank	Boat	Combined	Bank	Boat	Combined
1	0.13	2.06	0.13	0.18	0.35	0.21
2	0.43	0.26	0.35	0.38	0.63	0.55
3	0.35	0.56	0.37	0.66	0.62	0.63
4	0.28	0.54	0.32	0.62	1.01	0.78
5	0.12	0.52	0.23	0.95	0.87	0.90
Totals	0.23	0.39	0.26	0.39	0.66	0.53

	1969			1970		
Section	Bank	Boat	Combined	Bank	Boat	Combined
1	0.08	0.64	0.12	0.16	0.26	0.16
2	0.22	0.18	0.19	0.25	0.34	0.31
3	0.41	0.40	0.40	0.21	0.49	0.37
4	0.35	0.47	0.44	0.20	0.47	0.35
5	0.54	0.55	0.54	0.46	0.39	0.41
Totals	0.23	0.36	0.31	0.21	0.43	0.30

Wiley (1969), in 1968 (Table 19), and Rasmussen (1956), 0.69 in 1955, for cutthroat trout from the Snake River. The Snake River success rates in 1969 and 1970 are also lower than those of the North Platte River, 0.65, (Kanaly, 1969); the Green River between Flaming Gorge Reservoir and Fontnelle Dam, 0.46, (Elserman, et. al., 1967); and, in Idaho, the St. Joe River, 0.7, (Rankel, 1970).

A difference in catch per hour was noted between study areas (Table 19). As in former years, the success rates were lowest in Section 1. As noted previously, this difference has been attributed to periodic high volume flows and a difference in stream ecology. In 1969 and 1970, Section 5 had the highest success rate. The overall success rates in 1970 were somewhat lower than in 1969. This has been attributed to the greater flows in 1970.

The data shown in Table 19 continue to show that the success rates of boat fishermen are greater than those of bank fishermen. This difference is attributed to access by boat fishermen to areas having less fishing pressure.

In the low water year of 1969, the greatest success rates for bank fishermen were generally realized from late August through October, when the cutthroat are generally isolated in the deeper pools, and are more vulnerable. Boat fishermen success rates in 1969, attained their peak during July and August in Sections 2 through 5, while Section 1 reached its peak in September. While the importance of food availability and warmer, clearing water are the contributing factors for higher success rates during the summer months for boat fishermen, they seem to create problems for the bank fishermen. Fishermen are generally restricted to access areas which are heavily fished. This seems to be the probable reason for reduced success in the

summer months and an increase in success during the fall months when such pressure is reduced.

During the high water year of 1970, the greatest success rate for bank fishermen occurred in September and October. With the exception of Section 5, these were also the peak months for boat fishermen success rates in 1970. It is quite evident that the high water conditions of 1970 influenced fishermen activity on the river.

Tackle Efficiency. In 1969 and 1970, the type of terminal tackle used by successful fishermen was recorded on the creel census forms (Appendix 2), under the appropriate heading. The type of terminal tackle used was classified as follows: bait--worms or bait fish (cyprinids and cottids); flies--artificial dry and wet patterns; hardware--lures and spinners.

Wiley (1969), found bait to be the most effective tackle in 1967 and 1968. In order to make a comparison of data, the 1969 and 1970 data were grouped into spring (April through June), summer (July and August), and fall (September and October) seasons. The efficiency of the terminal tackle was then computed as the percentage of fish caught by a particular tackle. Bait was found to be the most effective type of tackle used in both years (Table 20).

However, an overall analysis of Section 1 through 5 for the entire years of 1969 and 1970 respectively, indicates

Table 20. Seasonal tackle efficiency of flies, bait and lures. Expressed as percentage of fish caught by or type of tackle, Snake River, 1969 and 1970.

	Flies		Bait		Lures	
Season	1969	1970	1969	1970	1969	1970
Spring	12.5	0.0	75.0	68.5	12.5	31.5
Summer	35.1	28.5	29.5	47.3	35.4	24.2
Fall	65.8	67.0	19.2	11.2	15.0	21.8
Mean Totals	37.7	31.9	41.3	42.5	20.9	25.7

that successful anglers had the greatest success with artificial flies in both years (Table 21).

These data support the management view that tackle efficiency varies with the time of the year. These data also seem to support the hypothesis that artificial flies are the most successful tackle type used on a yearly basis. However, this may be due to a general increase in the use of artificial flies by fishermen on the Snake River.

Fisheries personnel have noted an increased interest in fly fishing in Jackson Hole during recent years, as well as an increase in the promotion of fly fishing by local sportsmen. Contests and fly fishing instructions for children and adults are examples of such promotional interests generated in 1969 and 1970. A trend toward

Table 21. Summary of tackle efficiency on harvest of cutthroat trout by study section, Snake River, 1969 and 1970.

	1969			1970		
Area	Flies	Bait	Lures	Flies	Bait	Lures
Section 1						
Bank	11	20	5	19	65	18
Boat	9	--	10	6	--	--
Section 2						
Bank	26	--	1	11	5	--
Boat	61	--	23	41	--	7
Section 3						
Bank	21	17	--	46	22	7
Boat	8	29	--	144	25	76
Section 4						
Bank	37	8	5	79	67	16
Boat	73	34	79	189	122	164
Section 5						
Bank	39	21	6	48	60	10
Boat	7	52	14	35	108	36
Combined Total	292	181	195	618	474	334
Percent Efficiency	43.7%	27.1%	29.2%	43.4%	33.2%	23.4%
Average Length Section 3-5	10.93 in.	11.23 in.	11.72 in.	11.45 in.	10.61 in.	11.68 in.

increased use of artificial flies is becoming quite evident, and may affect management policies in future years.

Movement of Tagged Cutthroat Trout. In 1969, the Park Service clipped the adipose fin of 591 cutthroat in Sections 1 and 2. Unfortunately, no measurements were taken on these marked fish. Wyoming Game and Fish management personnel marked a total of 687 cutthroat by removing the left ventral fin. Of these 687 marked cutthroat, 369 were 8 inches or more in length. Although the number of marked cutthroat recovered is quite small, there is sufficient location data for recoveries to evaluate their movements.

Of the 26 confirmed recoveries in 1969, 80.8 percent were recovered in the same area in which they were marked, 11.5 percent were recovered downstream from the marking area, and 7.7 percent were recovered upstream from the marking area (Table 22).

Table 22. Movement of marked cutthroat trout in the Snake River, 1969 and 1970.

Movement	Number of Fish		Percent of Total	
	1969	1970	1969	1970
Upstream	2	7	7.7	24.2
No movement	21	19	80.8	65.5
Downstream	3	3	11.5	10.3

The two cutthroat harvested after moving upstream had an approximate average movement of 12.3 miles, with a range from 1 to 24.5 miles. The three cutthroat harvested after downstream movement had an approximate average movement of 9.7 miles, with a range of 7 to 19.5 miles.

In 1970, Wyoming Game and Fish personnel marked 246 cutthroat by removing the right ventral fin. An estimated 312 marked cutthroat survived into the 1970 fishing season. Once again small numbers of marked fish were recovered, however, enough data were available to evaluate their movement.

In 1970, there were 29 confirmed recoveries of marked cutthroat trout, of which 65.5 percent were harvested in the same area in which they were marked, 24.2 percent were recovered upstream from the marking area, and 10.3 percent were harvested downstream from the marking area (Table 22).

A total of seven cutthroat harvested after moving upstream had an approximate average movement of 5.5 miles, with a range of 1 to 7 miles above Section 4 and 1 to 4 miles above Section 2. A 1969 left ventral clipped cutthroat was recovered in the Bar B C Spring Creek fish trap. This tributary to the Gros Ventre River is located about one-half mile above the confluence of the Gros Ventre with the Snake River in Section 3, and is known to be an important cutthroat trout spawning area (Hayden, 1968). There

was also an unconfirmed report of the recovery of a 1969 marked cutthroat taken near the mouth of the Buffalo Fork River which is some 34 miles above the area in which it was marked.

The three cutthroat trout recovered downstream from the marking area had moved an average of 23.2 miles, with a range of 7 to 39.5 miles.

Miller (1957), studied the permanence and size of home territories of cutthroat trout dwelling in small streams. Miller's investigation showed that 67 percent of the tagged cutthroat were recaptured in the original pool or less than 200 yards from it. The remaining fish drifted downstream; these tended to be smaller in size than those which did not drift. Miller (1957), suggested that each cutthroat has a home territory not over 20 yards long and that they generally spend their entire life in this homing area. In another study, Miller (1954), found that cutthroat of upstream origin, when transplanted downstream, will attempt to return to their homing area. Once again his study was conducted in a small stream, however, these projects seem to indicate a strong territorial sense in cutthroat trout.

Studies of cutthroat trout movement, in the Middle Fork of the Salmon River of Idaho, conducted by Mallet (1961), seem to indicate a strong downstream movement of from 1 to 80 miles and some upstream movement with a range of 1 to 57

miles. He noted a trend of larger fish moving upstream, but no correlation between size and distance traveled by fish moving downstream.

Rankel (1970), conducted research in Idaho on the St. Joe River cutthroat trout and found that 70.6 percent of the tagged cutthroat were recovered within 1 mile of the release site. Downstream movement made up 20.6 percent, while upstream movement comprised only 8.8 percent.

Due to the small sample of recoveries in this study, it is mere speculation in considering the evaluation of upstream and downstream movements. However, what data are available, seem to indicate a homing tendency, with upstream and downstream movements being dictated by spawning and by stream flow conditions.

Harvest of Non-Cutthroat Species. Harvest estimates, of fish other than cutthroat trout, were calculated using the proportional methods as described on page 35. This formula was utilized in calculating such harvest estimates for each month, bank fishermen, and also for boat fishermen during 1969 and 1970. Tables 23 and 24 respectively, represent the harvest estimates of non-cutthroat trout in Sections 1 through 5 for 1969 and 1970.

Section 1 (Tables 23 and 24) shows the greatest harvest of lake trout which is attributed to escapement from Jackson Lake.

Table 23. Harvest estimates of non-cutthroat species, Sections 1 through 5, Snake River, 1969.

Section	Rainbow	Brook	Brown	Mackinaw	Hybrid*	Whitefish	Utah Suckers	Utah Chubs
1	10	0	15	48	0	48	49	139
2	0	8	0	0	15	100	10	10
3	6	0	0	0	0	156	0	39
4	23	0	0	0	0	268	82	6
5	0	0	0	0	0	58	6	6
Totals	39	8	15	48	15	630	147	200

*Hybrid (Rainbow x Cutthroat)

Table 24. Harvest estimates of non-cutthroat species, Sections 1 through 5, Snake River, 1970.

Section	Rainbow	Brook	Brown	Mackinaw	Hybrid*	Whitefish	Utah Suckers	Utah Chubs
1	0	0	0	354	0	---------	605**	--------
2	0	6	0	0	0	---------	69**	--------
3	7	3	0	3	11	254	65	10
4	6	24	0	3	0	359	232	21
5	0	0	4	0	0	115	49	21
Totals	13	33	4	360	11	728	346	52

*Hybrid (Rainbow x Cutthroat)

**674 Non-trout Species Not Identified

The mountain whitefish (Prosopium williamsoni), the Utah chub (Gila atraria), and the Utah sucker (Catostomus ardens) are all native to the Snake River Drainage.

The brook trout (Salvelinus fontinalis), brown trout (Salmo trutta), lake trout (Salvelinus namaycush), and rainbow trout (Salmo gairdneri) have all been introduced into the Snake River Drainage.

DISCUSSION

That part of the data collected in this study pertaining to harvest repeated the study made by Wiley (1969), although it involved certain modifications in methods. Because of these differences, comparisons between the data collected in 1969 and 1970 and those collected in 1967 and 1968 have been discussed at some length in preceding sections.

In fisheries management the determination of stock densities and estimates of harvest provide basic information essential to establishing management policies.

The consideration of the 1969 and 1970 population estimates of Section 4 (Tables 5 and 8), leads us to suspect that cutthroat stock densities in the Snake River fluctuate from year to year in relation to the volume of discharge from Jackson Lake Dam. Analysis of harvest data from 1969 and 1970 (Tables 10 and 11) suggests, also, a strong influence of volume flow on harvest. Due to the differences in census methods each year from 1967 through 1970, the differences in the estimates of harvest cannot yet be interpreted with certainty.

Over-exploitation of fisheries has been discussed and defined by several prominent fisheries experts. Lagler

(1970), believed that reduced catches (or drop in success rates) are a first indication of over-exploitation. Rounsefell and Everhart (1953), also felt that such a decline in catch per unit of effort is the first and most noticeable effect of declining stock abundance, although it may only be a temporary phenomenon. Gulland (1968), stated that a fishery may be appraised by measuring the effects of fishing, such as a decline in catch per unit effort, a decrease in average age, or an increase in total mortality. In any case, the problem of possible over-exploitation of the Snake River cutthroat trout is of basic concern to personnel responsible for the management of this valuable fishery.

Three criteria to be used as a basis for judgement as to whether the Snake River fishery is approaching over-exploitation will be examined: (1) an estimate of the rate of exploitation, (2) the percentage of young fish in the harvest, and (3) fishing success rates.

For Section 4 of the river, if we may assume that recruitment during the fishing season approximates the mortality (type IIA fishery as described by Ricker, 1958, p. 29) then the population estimate, made as it was over a period of several months, represents an estimate of average stock density for the summer period, and the annual rate of exploitation would be calculated as:

$$\frac{\text{Estimated Harvest}}{\text{Population Estimate}}$$

For 1969, this is $\frac{1861}{4002} = .465$, and for 1970, $\frac{2174}{9919} = .219$.

Fishing efforts in these two years were 1216 and 2109 fishermen respectively, so there is no apparent correlation between catch and effort. The judgement as to whether or not these estimates are realistic must wait for better estimates of the stock densities of cutthroat trout in the Snake River. The rather large differences in the estimates of stock density and harvest between the two years suggest that the fishery is not stable and both year class strength and harvest vary considerably from year to year, probably in relation to annual differences in volume flow. Nevertheless, if the total mortality rate of .66 for 1967-1968 (page 35) should represent an average figure for the period 1967-1970, then the rates of fishing mortality calculated above would not normally be considered excessive for a stream trout fishery.

Decreases in the average age and size of fish in a population have been regarded as an indication of decreasing population densities (Rounsefell and Everhart, 1953). Such a decrease needs to be shown by data collected over a number of years, and of sample size such that apparent trends can be evaluated statistically in order to be accepted as valid. Due to the fact that fishermen are obviously returning fish

less than 9 inches (Figures 4 and 5) the average size of cutthroat trout harvested over a period of many years (see Wiley, page 25) from the Snake River cannot be utilized as a basis for judging the state of the fishery in regard to possible over-exploitation. The constant average length of fish caught is probably linked to the fishermen selectivity, and may not be construed as meaning that the fishery is stable (Table 25).

Wiley (1969), suggested that over-exploitation might be indicated when cutthroat trout less than 11 inches long (largely Age II fish) make up 75 percent or more of the harvest. Wiley noted that such a condition was approached during 1967 in Section 2 when this percentage was 74.4, but for the fishery as a whole he concluded that there was "no reason to consider the Snake River fishery to be over-exploited." No such high proportions of Age II fish were approached in 1969 or 1970 in any study sections (Table 25).

Table 26 depicts the composition of the cutthroat harvest by size groups from 1967 to 1970. Once again the differences between years are apparently due to fisherman, selectivity and fluctuating volume flows. However, even with fishermen selectivity for larger fish, the proportion of fish over 15 inches in length is only slightly less than in past years.

The fishing success rates during 1969 and 1970, in comparison with past years (Table 26) seem to have stabilized

Table 25. Percent composition of the catch in different sections of the Snake River by size groups, 1969 and 1970.

1969

Section	Sample sizes	Less than 11 inches	11-15 inches	Over 15 inches	Average length
1	89	69.6	23.6	6.8	10.6
2	191	60.7	37.2	2.1	10.7
3	98	51.0	38.9	10.1	11.5
4	192	58.3	36.5	5.2	10.8
5	136	52.9	40.1	7.4	11.2
Totals	706	58.4	35.2	6.3	10.9

1970

Section	Sample sizes	Less than 11 inches	11-15 inches	Over 15 inches	Average length
1	97	62.9	27.8	9.3	10.6
2	42	45.2	47.6	7.2	11.3
3	292	50.0	35.3	14.7	11.0
4	562	51.4	37.7	10.9	11.5
5	303	57.7	40.3	2.0	10.7
Totals	1,296	53.4	37.7	8.9	11.0

although long-term trends have not yet been established definitely. At present it is believed that the differences from year to year in success rate are due to differences in physical conditions (primarily volume flow) and not to a drastic reduction in the catchable stock that would indicate over-exploitation. Further trend data indicating changes over a long period of time would be a better indicator

of changing stock densities (Rounsefell and Everhart, 1960). It is also probable that fishermen selectivity has had an important effect on apparent catch per effort causing it to appear to be constant. Many of the fishermen interviewed told census takers they caught and released many smaller fish.

Table 26. Percent composition of the catch of cutthroat trout by size groups, average length, and success rates, Snake River, 1967-1970.

Year	Section	Less than 11 inches	11-15 inches	Over 15 inches	Average length	Success rate
1967	1-6	57.8	32.4	9.8	11.0	0.29
1968	1-6	47.9	40.0	12.1	11.6	0.53
1969	1-5	58.5	35.2	6.3	10.9	0.31
1970	1-5	53.4	37.7	8.9	11.0	0.30

All fish populations are limited in size, and held at some fluctuating level by natural controls (Ricker, 1954). Such controls involve either competition and environmental variability, or both. In the Snake River during those years when volume flows are low, resulting in high rates of exploitation, the spawning stock may be decreased to such size that the year class resulting from that years' reproduction may be noticeably decreased. Ricker (1958), stated

that variable environments result in variable recruitment to the population, which causes the catch to fluctuate even if the rate of exploitation is the same in all years. Such fluctuations are more significant if mature fish are harvested before they have an opportunity to spawn.

Another consideration in the Snake River fishery is species selectivity by fishermen. The mountain whitefish, (as shown in Tables 23 and 24, pages 64 and 65), may be a competitor with cutthroat for space and possibly food, in the case of younger age classes. Those years characterized by low volume flows may result in a greater intensity of competition for living space and food.

Murphy (1966), stated that selective fishing will alter the equilibrium state of the population to the disadvantage, or even extinction of the selected fish. Should selective fishing be significant, the cutthroat trout in the Snake River is at a disadvantage in competition with the mountain whitefish unless the capacity of the cutthroat to increase is high enough to compensate for such selectivity. For this reason, future changes in species composition should be monitored as an index to changes in the condition of the fishery.

In any case, the only evidence supporting the possibility of over-exploitation is a slight decrease in the catch of larger fish and declining success rates which may only be a temporary condition. Without long term trend data to

establish the validity of trends, we cannot presently state with any certainty whether or not the fishery is presently over-exploited. The correlation between catch and volume flows so distorts the relation between catch per unit effort and stock density that reliable judgements on exploitation cannot be made. However, the indicators of exploitation cannot be ignored and should be followed by monitoring at least one area in the Snake River for several more years in order to obtain trend data that are meaningful.

RECOMMENDATIONS

1. An additional year of programmed creel census is needed to consolidate the data collected during the past two segments. Data obtained from this survey would provide additional harvest information, as well as possible stock density and survival data from the remaining marked fish.
2. Continued monitoring of at least one study area for several more years in order to develop long term trend data which could be utilized to determine possible changes in stock densities is recommended. A sample comprised of scales from a minimum of 100 creeled fish, in the size range 7.5 to 12.5 inches in length (Age II and III) should be obtained from the harvest each year. The analysis of these data would be instrumental in showing the proportion in the catch of the Age II and Age III fish. Such data would be valuable in developing future management policies.
3. The present creel limit of six trout should be maintained until the evaluation of the next segment of the cutthroat study has been made. Although there seems to be some preliminary evidence of increased exploitation of cutthroat trout in the Snake River in recent years, the harvest is still apparently primarily a function of physical conditions of the river.

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APPENDICES

Appendix I. Snake River Creel Census, 1969

	April				
	River Sections				
Date	1	2	3	4	5
1	B				R
2		R			
3			B		
4				R	
S 5					
S 6					
7					
8		R	R	B	
9		B	B		
10		B			
11	R				R
S 12					
S 13			R	B	
14		R		R	
15					
16			B, R		
17		R		B	
18	B			R	B
S 19	R			R	
20			R	B	
21	B				

Appendix I, continued.

April

Date	River Sections 1	2	3	4	5
22		B	B		R
23					
24		B			
25	R				B
S 26					
S 27					
28					B,R
29	R				
30	B				B

May

1	B			B	
2					
S 3					B,R
S 4	R		R		
5		B	B		
6				R	B
7					
8	R		R		
9			R		
S 10					

Appendix I, continued.

	May				
	River Sections				
Date	1	2	3	4	5
S 11			B		
12	B			B,R	
13		B		B	
14		R			
15		R			R
S 16					
S 17	B				
18					R
19		B	R		
20		B			
21	R		B		
22				R	B
23					
S 24					
S 25					
26		R		R	
27		R			B
28			B		
29	R				
30					
S 31	B			B	R

Appendix 1, continued.

	July				
	River Sections				
Date	1	2	3	4	5
1	B			R	
2	R				R
3		B		B	
4					
S 5					
S 6					
7					B
8	R		B		
9					
10				B	
11					
S 12			R		
S 13	B				
14		B,R			
15	R		B		
16				R	
17		R		B	R
18		B			
S 19		B	R		
S 20					

Appendix 1, continued.

	July				
	River Sections				
Date	1	2	3	4	5
21					
22	B				
23	R				B,R
24	B		R	B	
25				R	
S 26					B
S 27					
28				R	B
29		R	B		
30					R
31		R	B,R		

	August				
1	R		B		
S 2	B				
S 3		B			
4	B	B			
5			B	R	
6					R
7					R
8					

Appendix 1, continued.

	August				
	River Sections				
Date	1	2	3	4	5
S 9					B
S 10					R
11		R	R		
12				B	
13				R	
14				B	
15					B
S 16		R		B	
S 17		B,R	R		
18			B		
19					R
20	B				
21		B		R	B
22				R	
S 23				B	
S 24	R		R		
25	B,R		R		
26				B	
27					
28	R				
29					

Appendix I, continued.

August

River Sections

Date	1	2	3	4	5
S 30					
S 31		R	B		

September

1		B	R	B	
2	B				B,R
3					
4	B			R	
5		R	B		
S 6				B,R	
S 7			B		
8		B			
9					R
10					
11			B		
12	B,R				B
S 13					
S 14					
15		R			B,R
16		R	R		
17		B			

Appendix 1, continued.

	September				
	River Sections				
Date	1	2	3	4	5
18	B		R		
19		B			
S 20	R			R	B
S 21	R				
22				B	
23	R				
24					
25				B,R	
26					
S 27					R
S 28			R		
29		R	B		
30					
	October				
1	R			B,R	
2		B			R
3		B		R	
S 4					
S 5	B				
6		B		R	

Appendix I, continued.

	October				
	River Sections				
Date	1	2	3	4	5
7			B		
8	B				B
9		B			B,R
10					
S 11			R		
S 12					
13			R		
14					
15	B	R			
16				B	
17					R
S 18					
S 19	R				
20			B		
21					B,R
22					
23		R			
24	R		R	B	
S 25		R	B		
S 26		R		B	
27					

Appendix I, continued.

October

River Sections

Date	1	2	3	4	5
28				R	B
29	B		R		
30					
31	R		B		

Symbols	Times
B - Bank	Bank Interviews - 1200-1800 - Areas 1-5
R - River	Boat Interviews - 1200-1800 - Areas 1-5

Appendix 2.

Bank Fishermen Interview Form

Location_____ Date_____

Time sheet started_____ Time sheet finished_____

Individual

	1	2	3	4	5	6	7	8	9	10
License[1]										
Hours on river										
Hours fishing										
Through										
Not Through										
Fish caught										
No. Cutthroat										
Marks										
No. Brook										
Marks										
No. Brown										
Marks										
No. Rainbow										
Marks										
No. Non-trout										
Marks										
Bait[2]										
Flies[2]										
Hardware[2]										
Access Point[3]										

[1]License: A = Res B = RY C = Underage res D = NR season T = Non-licensed E - 5DTF F - Underage NR

[2]Number of fish caught by these.

[3]Access: 1 = Pacific Creek 2 = Moose 3 = Wilson Bridge 4 = South Park 5 = Astoria 6 = Elbow 7 = Canyon Mouth

Appendix 2, continued.

BOAT INTERVIEW FORM

Location_____ Date_____

Time sheet started_____ Time sheet finished_____

Category	Boats interviewed 1	2	3	4	5	No. boats through	No. boats launching
Outfitter							
Private							
No. in party							
No. interviewed							
License[1]							
Total hours fished (party)							
Shore hours							
No. fishing shore							
Fish caught							
No. Cutthroat							
Marks							
No. Brook							
Marks							
No. Brown							
Marks							
No. Rainbow							
Marks							
No. Non-trout							
Marks							
Bait[2]							
Flies[2]							
Hardware[2]							
Launch point[3]							

[1]License: A = Res; B = RY; C = Underage res; D = NR season; T = Non-license; E = 5 DTF; F = Underage NR

[2]Number of fish caught by these.

[3]Launch: 1 = Moran; 2 = Pacific Creek; 3 = Moose; 4 = Wilson Bridge; 5 = South Park; 6 = Astoria; 7 = Elbow; 8 = Canyon Mouth

Appendix 3. Snake River Creel Census, 1970.

Date	Dam to Pacific Creek		Pacific Creek to Moose	
	April	May	April	May
1			B	
2		B		
3	R			
4				
5		B		
6	R		R	R
7	B			
8				
9				B
10				
11			B	
12	R			
13		B		B
14				
15				
16	B		R	
17				R
18	B			B
19		B,R	R	
20			B,R	B
21				
22				

Appendix 3, (continued)

Date	Dam to Pacific Creek		Pacific Creek to Moose	
	April	May	April	May
23				
24				
25		R		R
26				R
27		R	B	
28				
29	R			
30	B	R		

Appendix 3, (continued)

DAM - PACIFIC CREEK
1970 Creel Survey

Date	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
1		B	R		
2	R	B	B	R	
3		B			R
4	B,R	R	R	B	
5		R		R	
6	B			B	B
7		R	R	B	
8		R	R		
9	R				B,R
10				B	R
11		R	R		
12	B			B	R
13	B		B,R	B	R
14					
15			B		
16				B	
17	B	R			B
18	R	B	B	R	B
19	R	B		B	
20				R	R
21	B,R				R

Appendix 3, (continued)

Date	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
22	R	R	B	R	
23	B			R	
24			B		
25	R	B			R
26			R	B	B
27	B	B	B	R	R
28	R	R	B,R	R	
29	R	R	R		
30	B	B		R	B
31		B	B		B

PACIFIC CREEK - MOOSE
1970 Creek Survey

Date	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
1				R	R
2			R	B	B
3			B		
4		R	R	B	B
5		B	R	R	
6				R	
7		B	B		R
8			R	B	

Appendix 3, (continued)

Date	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
9		R		R	B
10					
11		B	R	R	R
12				B	B
13		R	R	R	R
14		B,R			R
15			R	R	R
16					
17		B,R			R
18		R	B	R	
19		B		B	B
20			B		
21		B	B		B
22			B	B	
23	B	B	R	R	
24			B	B	R
25	B	R		B	B
26		B			B
27	R	R		B	
28	R	R			
29	B		B		

Appendix 3, (continued)

Date	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
30	R		B		R
31			R		B

Symbols

B - Bank--To be conducted between 12:00-6:00 P.M.

R - River--To be conducted between 12:00-6:00 P.M.

Census based on 9 days per area/bank/boat.

JUNE CREEL CENSUS

1970

Date	AREA 3	AREA 4	AREA 5
20	B	B	
21		R	B
22			B
23	B	R	
24		B	
25	R		
26			R
27	R	B	
28	B		B,R

Appendix 3, (continued)

Date	AREA 3	AREA 4	AREA 5
29		R	
30	R		R

Symbols

B - Bank Fisherman--To be conducted between 12:00-6:00 P.M.

R - Boat Fisherman--To be conducted between 12:00-6:00 P.M.

Census dependant upon water conditions.

JULY CREEL CENSUS

1970

Date	AREA 3	AREA 4	AREA 5
1	R		B
2		R	
3	R		B
4		R	B
5	B,R	R	
6			B
7	B	B	
8			R
9	R		

Appendix 3, (continued)

Date	AREA 3	AREA 4	AREA 5
10		R	
11	R	B	R
12	B		B
13		R	
14			B
15	B	B	
16		B	
17	B	R	
18		B	R
19	B		R
20	R	B	
21	B		R
22		R	R
23			B
24	R	B	
25	B	R	
26	R	B	B
27			B
28			R
29	R	B	R
30		R	
31	B		R

Appendix 3, (continued)

AUGUST CREEL CENSUS

1970

Date	AREA 3	AREA 4	AREA 5
1	B	R	
2	R	R	
3		B	
4		R	B,R
5		B	B
6	B		R
7			B
8	B		B
9		R	B
10	B		R
11	R	B	R
12	B	R	
13		B	
14		R	
15		R	
16			R
17			R
18	B		B
19	B	B	R
20	R		

Appendix 3, (continued)

Date	AREA 3	AREA 4	AREA 5
21		B	R
22	B		
23	R	R	
24		B	R
25	R	B	
26	R	R	
27	B		B
28			B
29	R	B	
30	R		
31	R		B

SEPTEMBER CREEL CENSUS

1970

1	R		B
2		R	R
3		B	R
4	B	B	
5	R	B	
6	B	R	

Appendix 3, (continued)

Date	AREA 3	AREA 4	AREA 5
7	B		B
8	B		B
9		R	B
10	B	R	
11	R		
12		B,R	
13	B		B,R
14		B	B
15	R		
16	B		
17		R	R
18	B		
19	R	B	B
20	R		R
21			B
22	R		
23	R		R
24	R	R	
25		B	
26	B		R
27		R	B
28		B	

Appendix 3, (continued)

Date	AREA 3	AREA 4	AREA 5
29		R	R
30		B	R

OCTOBER CREEL CENSUS

1970

1	B		R
2		R	B
3		R	B
4	B	R	
5	B	R	
6	B	R	
7	R	B	
8	B		R
9	B		R
10	B	B	
11		R	R
12	R		
13		R	
14		B	B
15	R		

Appendix 3, (continued)

Date	AREA 3	AREA 4	AREA 5
16		B	
17	R		R
18	R	B	
19			R
20	R		
21	R	R	
22			B
23		B	
24	R		B
25	B		R
26	B	B	
27			R
28		B	
29			B
30	R	R	
31		B	B,R

Symbols

B - Bank Fisherman--To be conducted between 12:00-6:00 P.M.

R - Boat Fisherman--To be conducted between 12:00-6:00 P.M.

Appendix 4. Snake River Bank and Boat Summary.

AREA I BANK 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
April											
Wk Days	3	3	3		3		3				
Wk-end Days											
May											
Wk Days	2	8	6.5		6.5		3			2	1
Wk-end Days	2	10	16.0		16.0		2			1	1
June											
Wk Days	4	78	112.0	11	101.0		5		1	4	
Wk-end Days											
July											
Wk Days	4	86	127.0	3.5	123.5		12		7	5	
Wk-end Days											
August											
Wk Days	3	101	106	8	98		6			6	2
Wk-end Days	1	19	31	15	16	2				2	
September											
Wk Days	3	23	36	13	23	1	3		3	1	
Wk-end Days											
October											
Wk Days	3	3	3	1	2		2				2
Wk-end Days											
TOTALS											
Wk Days	22	302	393.5	36.5	357.0	1	34		11	18	5
Wk-end Days	3	19	47	15	32	2	2			3	1
TOTAL	25	321	440.5	51.5	389.0	3	36		11	21	6

Appendix 4, (continued)

AREA 1 BANK 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days				3	2	3						
Wk-end Days												
May												
Wk Days	3	2	.5	5	1	4.0						
Wk-end Days	7	1	11.5	3	1	4.5	1				6	
June												
Wk Days	10	4	14	68	1	98	4			1	2	
Wk-end Days												
July												
Wk Days	1		1	53	12	121.5	15			1	3	
Wk-end Days												
August												
Wk Days	7		8.5	94	8	97.5	5					
Wk-end Days	1		0.5	18	2	30.5	3					
September												
Wk Days	1		1	22	4	35	1				1	
Wk-end Days												
October												
Wk Days	1		1	2	2	2		1				
Wk-end Days												
TOTALS												
Wk Days	23	6	26	247	40	361	26	1		2	6	
Wk-end Days	8	1	12	21	3	35	4				6	
TOTAL	31	7	38	268	43	396	30	1		2	12	

Appendix 4, (continued)

AREA 1 BOAT 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
April											
Wk Days											
Wk-end Days	2										
May											
Wk Days	3										
Wk-end Days											
June											
Wk Days	2										
Wk-end Days											
July											
Wk Days	2										
Wk-end Days											
August											
Wk Days	3										
Wk-end Days	1	1	2.5	2.5		1				1	
September											
Wk Days	2	6	27	27		18			9	9	2
Wk-end Days	2										
October											
Wk Days	2										
Wk-end Days	1										
TOTALS											
Wk Days	14	6	27	27		18			9	9	2
Wk-end Days	6	1	2.5	2.5		1				1	
TOTAL	20		29.5	29.5		19			9	10	2

Appendix 4, (continued)

AREA 1 BOAT 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days												
Wk-end Days												
May												
Wk Days												
Wk-end Days												
June												
Wk Days												
Wk-end Days												
July												
Wk Days												
Wk-end Days												
August												
Wk Days												
Wk-end Days				1	1	2.5						
September												
Wk Days	2			4								
Wk-end Days												
October												
Wk Days												
Wk-end Days												
TOTALS												
Wk Days	2			4								
Wk-end Days				1	1	2.5						
TOTAL	2			5	1	2.5						

Appendix 4, (continued)

AREA 2 BANK 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Harvest Methods Bait	Harvest Methods Lures
April											
Wk Days	3	1	1		1						
Wk-end Days											
May											
Wk Days	1										
Wk-end Days											
July											
Wk Days	2	21	26.5		26.5		5		5		
Wk-end Days	1	4	4		4						
August											
Wk Days	3	12	36.5	8	28.5	1					1
Wk-end Days											
September											
Wk Days	4	23	33.5		33.5		18	2	18		
October											
Wk Days	4	3	6		6		3		3		
Wk-end Days											
TOTALS											
Wk Days	17	60	102.5	8	94.5	1	26	2	26		1
Wk-end Days	1	4	4		4						
TOTAL	18	64	106.5	8	98.5	1	26	2	26		1

Appendix 4, (continued)

AREA 2 BANK 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days				1		1						
Wk-end Days												
May												
Wk Days												
Wk-end Days												
July												
Wk Days	2	1	5.5	19	4	23	2					
Wk-end Days				4		4						
August												
Wk Days	1		2	11	1	34.5						
Wk-end Days												
September												
Wk Days	2		2.5	21	18	31	4					
Wk-end Days				4		9						
October												
Wk Days	3	3	6									
Wk-end Days												
TOTALS												
Wk Days	8	4	16	52	23	89.5	6					
Wk-end Days				8		13						
TOTAL	8	4	16	60	23	102.5	6					

Appendix 4, (continued)

AREA 2 BOAT 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Harvest Methods Bait	Harvest Methods Lures
April											
Wk Days	3										
Wk-end Days											
July											
Wk Days	3	19	79	79		21			9		12
Wk-end Days	1	10	53.5	53.5		11		1	4		7
August											
Wk Days	3	27	152.5	152.5		19		1	15		4
Wk-end Days	1	12	64	64		8			8		
September											
Wk Days	4	21	130	130		25		1	25		
Wk-end Days											
October											
Wk-Days	1										
Wk-end Days	1										
TOTALS											
Wk Days	14	67	361.5	361.5		65		2	49		16
Wk-end Days	3	22	117.5	117.5		19		1	12		7
TOTAL	17	89	479.0	479.0		84		3	61		23

Appendix 4, (continued)

AREA 2 BOAT 1969	No. Res. FMN	Resident Catch Cutt.	Resident Catch Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Non-Res. Catch Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days												
Wk-end Days												
July												
Wk Days	5			14								
Wk-end Days	2			8								
August												
Wk Days	6			21			9					
Wk-end Days	5			7								
September												
Wk Days												
Wk-end Days	10			11					1			2
October												
Wk Days												
Wk-end Days												
TOTALS												
Wk Days	11			35			9					
Wk-end Days	17			26					1			2
TOTAL	28			61			9		1			2

Appendix 4, (continued)

AREA 3 BANK 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Harvest Methods Bait	Harvest Methods Lures
July											
Wk Days	4	22	26	17.5	8.5	5	3	1 adipose	4	5	
Wk-end Days											
August											
Wk Days	3	13	20	8	12	4	5		7	2	
Wk-end Days	1	13	31		31		11		6	5	
September											
Wk Days	3	6	6		6		2		2		
Wk-end Days											
October											
Wk Days	2	6	8.5	6.5	2	5	1	1 L.V	1	5	
Wk-end Days	1	1	1		1						
TOTALS											
Wk Days	12	47	60.5	32.0	28.5	14	12	2	14	12	
Wk-end Days	2	14	32.0		32.0		11		6	5	
TOTAL	14	61	92.5	32.0	60.5	14	23	2	20	17	

Appendix 4, (continued)

AREA 3 BANK 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	7	3	5	15	6	21						
Wk-end Days												
August												
Wk Days	4	7	5	9	2	14	8					
Wk-end Days	4	6	8.5	9	5	22.5						
September												
Wk Days	4	2	3	2		3	1					
Wk-end Days												
October												
Wk Days	7	6	9.5									
Wk-end Days												
TOTALS												
Wk Days	22	18	22.5	26	8	38	9					
Wk-end Days	4	6	8.5	9	5	22.5						
TOTAL	26	24	31	35	13	60.5	9					

Appendix 4, (continued)

AREA 3 BOAT 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	2	11	68	68		28		1 adipose			28
Wk-end Days	2	8	25.5	25.5		17			2	15	
August											
Wk Days	2	3	24	24		2					2
Wk-end Days	2	3	15	15		13					13
September											
Wk Days	3	10	50.5	50.5		15			1	14	
Wk-end Days	1	3	21	21		5			5		
October											
Wk Days	4										
Wk-end Days	1	3	21	21		9					9
TOTALS											
Wk Days	11	24	142.5	142.5		45		1	1	14	30
Wk-end Days	6	17	82.5	82.5		44			7	15	22
TOTAL	17	41	225.0	225.0		89		1	8	29	52

Appendix 4, (continued)

AREA 3 BOAT 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	4			7	5	5	18					
Wk-end Days	1			7			3					
August												
Wk Days	1			2								
Wk-end Days				3	13	15	1					
September												
Wk Days	1		6	6	14	16.5						
Wk-end Days				3	5	21	1					
October												
Wk Days												
Wk-end Days	1			2			1	1				
TOTALS												
Wk Days	5		6	15	19	21.5	18					
Wk-end Days	2			15	18	36	3	1				
TOTAL	7		6	30	37	57.5	21	1				

Appendix 4, (continued)

AREA 4 BANK 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	4	27	33.5	18.0	15.5	5	11	1 L.V.	10	5	1
Wk-end Days											
August											
Wk Days	3	24	52.5	49.5	3	7			7		
Wk-end Days	1	14	19.5	9.5	10	3	4	1 L.V.	4	3	
September											
Wk Days	3	15	26	20	6	2	2	1 L.V.	3		1
Wk-end Days	1	1	0.5		0.5		5	1 L.V.	5		
October											
Wk Days	3	5	5.5	4.5	1.0	2	6		5		3
Wk-end Days	1	2	4	2	2	1	2		3		
TOTALS											
Wk Days	13	71	117.5	92	25.5	16	19	2	25	5	5
Wk-end Days	3	17	24	11.5	12.5	4	11	2	12	3	
TOTAL	16	88	141.5	103.5	38.0	20	30	4	37	8	5

Appendix 4, (continued)

AREA 4 BANK 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	7	3	7	20	11	27.5	6					
Wk-end Days												
August												
Wk Days	3		8	21	7	44.5	4					
Wk-end Days	5	2	4.5	9	6	14	1					
September												
Wk Days	5	3	11.5	10	1	10.5						
Wk-end Days	1	5	0.5									
October												
Wk Days	4	8	5	1		0.5						
Wk-end Days	2	3	4									
TOTALS												
Wk Days	19	14	31.5	52	19	83	10					
Wk-end Days	8	10	9	9	6	14	1					
TOTAL	27	24	40.5	61	25	97	11					

Appendix 4, (continued)

AREA 4 BOAT 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	4	11	66.5	66.5		37		1 adipose	13	13	11
Wk-end Days											
August											
Wk Days	4	35	219.5	219.5		125		7 L.V.	39	21	65
Wk-end Days											
September											
Wk Days	2										
Wk-end Days	1	7	49	49		7		1 L.V.	6		1
October											
Wk Days	4	12	52	52		17		2 L.V.	15		2
Wk-end Days											
TOTALS											
Wk Days	14	58	338	338		179		10	67	34	78
Wk-end Days	1	7	49	49		7		1	6		1
TOTAL	15	65	387	387		186		11	73	34	79

Appendix 4, (continued)

AREA 4 BOAT 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	6			5								
Wk-end Days												
August												
Wk Days	9			26			36	3				
Wk-end Days												
September												
Wk Days												
Wk-end Days				7	7	49						
October												
Wk Days	4			7			2					
Wk-end Days												
TOTALS												
Wk Days	19			38			38	3				
Wk-end Days				7	7	49						
TOTAL	19			45	7	49	38	3				

Appendix 4, (continued)

AREA 5 BANK 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	3	8	10		10	4	1		1	4	
Wk-end Days	1	2	2	2		1			1		
August											
Wk Days	3	17	23.5	8.5	15.0	4	3		1	1	4
Wk-end Days	2	18	27	19	8	23		1 L.V.	14	9	
September											
Wk Days	3	20	37	6	31	2	26	1 L.V.	19	7	2
Wk-end Days	1	7	18	4.5	14.5		2		2		
October											
Wk Days	5	11	7.5	5		1			1		
Wk-end Days											
TOTALS											
Wk Days	14	56	78	19.5	56	11	30	1	22	12	6
Wk-end Days	4	27	47	25.5	22.5	24	2	1	17	9	
TOTAL	18	63	125	45.0	78.5	35	32	2	39	21	6

Appendix 4, (continued)

AREA 5 BANK 1969	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb Brk Brn Mck Hyb
July								
Wk Days	2	2	3	6	3	7		
Wk-end Days	2	1	2					
August								
Wk Days	2		3.5	15	7	20		
Wk-end Days	7	12	18	11	11	9	3	
September								
Wk Days	3		3	17	28	34	2	
Wk-end Days				7	2	18		
October								
Wk Days				11	1	7.5	1	
Wk-end Days								
TOTALS								
Wk Days	7	2	9.5	49	39	68.5	3	
Wk-end Days	9	13	20	18	13	27	3	
TOTAL	16	15	29.5	67	52	95.5	6	

Appendix 4, (continued)

AREA 5 BOAT 1969	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	4	10	44	44		24				17	7
Wk-end Days											
August											
Wk Days	3	11	39	39		28			4	21	3
Wk-end Days	1	5	8	8		11		1 L.V.	3	4	4
September											
Wk Days	3	8	42.5	42.5		10				10	
Wk-end Days	1										
October											
Wk Days	3										
Wk-end Days											
TOTALS											
Wk Days	13	29	125.5	125.5		62				48	10
Wk-end Days	2	5	8	8		11		1 L.V.	3	4	4
TOTAL	15	34	133.5	133.5		73		1	3	52	14

Appendix 4, (continued)

AREA 5 BOAT 1969	No. Res. FMN	Resident Catch Cutt.	Resident Catch Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Non-Res. Catch Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	1			9								
Wk-end Days												
August												
Wk Days	4			7			2					
Wk-end Days				5	11	8	2					
September												
Wk Days	2			6			9					
Wk-end Days												
October												
Wk Days												
Wk-end Days												
TOTALS												
Wk Days	7			22			11					
Wk-end Days				5	11	8	2					
TOTAL	7			27	11	8	13					

Appendix 4, (continued)

AREA 1 BANK 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
April											
Wk Days	3	5	7		7						
Wk-end Days	2	7	3.5		3.5						
May											
Wk Days	3	8	9	6	3	1				1	
Wk-end Days	1	6	12		12						
June											
Wk Days	4	136	202.5	3	116	3	14			9	8
Wk-end Days	3	126	171	8	163	1	19			16	4
July											
Wk Days	2	88	120	22.5	97.5		9			9	
Wk-end Days	1	37	50.5	3	47.5		6		2		4
August											
Wk Days	1	37	43.5	2	41.5		3		1	1	1
Wk-end Days	2	53	86.5	2	84.5		28		1	27	
September											
Wk Days	1	20	18.5	6	12.5		4		3		1
Wk-end Days	1	31	41.5	16	25.5	11	3		12	2	
TOTALS											
Wk Days	14	294	400.5	39.5	277.5	4	30		4	20	10
Wk-end Days	10	260	365	29	336.0	12	56		15	45	8
TOTAL	24	554	765.5	68.5	613.5	16	86		19	65	18

Appendix 4, (continued)

AREA 1 BANK 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days	5		7									
Wk-end Days	7		3.5									1
May												
Wk Days	2		3	6	1	6						
Wk-end Days	6		12									
June												
Wk Days	5		3.0	131	17	131.5	20					25
Wk-end Days	14	1	16.5	68	6	158	31					27
July												
Wk Days	14	6	17.5	74	3	110.5	10					4
Wk-end Days	5	1	7	32	5	43.5	1					
August												
Wk Days	2		1	35	3	42.5	10					
Wk-end Days	3	3	4.5	50	25	82	14					
September												
Wk Days	4		2	16	4	16.5						4
Wk-end Days	1		0.5	30	14	41	1					2
TOTALS												
Wk Days	32	6	33.5	262	28	307	40					33
Wk-end Days	36	5	44.0	180	50	324.5	47					30
TOTAL	68	11	77.5	442	78	631.5	87					63

Appendix 4, (continued)

AREA I BOAT 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
April											
Wk Days	1	4	Inc.								
Wk-end Days	1										
May											
Wk Days	2	3	6	6							
Wk-end Days											
June											
Wk Days	4	2	4	4							
Wk-end Days	2	1	5.5	5.5							
July											
Wk Days	4	3	6	6							
Wk-end Days	3	5	8	8							
August											
Wk Days											
Wk-end Days	1										
September											
Wk Days	1										
Wk-end Days	1	2	10	10		6		1 adipose	6		
TOTALS											
Wk Days	12	12	16	16							
Wk-end Days	8	8	23.5	23.5		6		1	6		
TOTAL	20	20	39.5	39.5		6		1	6		

Appendix 4, (continued)

AREA I BOAT 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days												
Wk-end Days												
May												
Wk Days												
Wk-end Days												
June												
Wk Days												
Wk-end Days							2					
July												
Wk Days												
Wk-end Days												
August												
Wk Days												
Wk-end Days												
September												
Wk Days												
Wk-end Days				2	6	10						
TOTALS												
Wk Days												
Wk-end Days				2	6	10	2					
TOTAL				2	6	10	2					

Appendix 4, (continued)

AREA 2 BANK 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Harvest Methods Bait Lures
April										
Wk Days	1									
Wk-end Days	1									
May										
Wk Days	2									
Wk-end Days										
August										
Wk Days	3	12	16.5	6	10.5	4	9		9	4
Wk-end Days	2	12	18	1	17	1	1		1	1
September										
Wk Days	2	6	14	11	3	1			1	
Wk-end Days										
TOTALS										
Wk Days	8	18	30.5	17	13.5	5	9		10	4
Wk-end Days	3	12	18	1	17	1	1		1	1
TOTAL	11	30	48.5	18	30.5	6	10		11	5

Appendix 4, (continued)

AREA 2 BANK 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days												
Wk-end Days												
May												
Wk Days												
Wk-end Days												
August												
Wk Days				8	3	8.5						
Wk-end Days	3	2	5	9		13						
September												
Wk Days	2		3	4	1	11	1					
Wk-end Days												
TOTALS												
Wk Days	2		3	12	4	19.5	1					
Wk-end Days	3	2	5	9		13						
TOTAL	5	2	8	21	4	32.5	1					

Appendix 4, (continued)

AREA 2 BOAT 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
April											
Wk Days	2										
Wk-end Days											
May											
Wk Days	1										
Wk-end Days	1										
July											
Wk Days	2	4	18.5	18.5		3					
Wk-end Days	2	7	44	44		6				2	
August											
Wk Days	3	17	47	47		24			20		4
Wk-end Days	2	8	35	35		19			19		
September											
Wk Days	1										
Wk-end Days	1										
TOTALS											
Wk Days	9	21	65.5	65.5		27			20		4
Wk-end Days	6	15	79	79		25			19	2	
TOTAL	15	36	144.5	144.5		52			39	2	4

Appendix 4, (continued)

AREA 2 BOAT 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
April												
Wk Days												
Wk-end Days												
May												
Wk Days												
Wk-end Days												
July												
Wk Days												
Wk-end Days							7					
August												
Wk Days												
Wk-end Days									1			
September												
Wk Days												
Wk-end Days												
TOTALS												
Wk Days									1			
Wk-end Days							7					
TOTAL							7		1			

Appendix 4, (continued)

AREA 3 BANK 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	5	37	56	50.5	5.5	14	1		9	5	1
Wk-end Days	4	39	47.5	31.0	16.5	11	5		3	12	
August											
Wk Days	6	46	74	69.5	3.5	8	2		7		3
Wk-end Days	3	29	53	53		8			5	2	1
September											
Wk Days	4	25	49.5	36.5	13	10	3		10	3	
Wk-end Days	3	20	35	15.5	4.5	2	4	1 L.V.	4		2
October											
Wk Days	6	17	33	6	27		5		5		
Wk-end Days	3	10	14	6	8	3			3		
TOTALS											
Wk Days	21	125	212.5	162.5	49	32	9		31	8	4
Wk-end Days	13	98	149.5	105.5	29	24	11	1	15	14	3
TOTAL	33	223	362.0	268.0	78.0	56	20	1	46	22	7

Appendix 4, (continued)

AREA 3 BANK 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	19	12	33.8	18	3	28.5	2					
Wk-end Days	14	8	6.2	25	7	35	10				1	
August												
Wk Days	6	2	7.5	40	8	74.5	10					
WK-end Days	9	5	24	20	3	29	17					
September												
Wk Days	6	11	12.5	19	2	37	2					1
Wk-end Days	10	2	10	10	4	20.5	4					
October												
Wk Days	1		1	16	5	32	3					
WK-end Days	6	3	10	1		4	16					
TOTALS												
Wk Days	32	25	54.8	93	18	172	17					1
WK-end Days	39	18	50.2	56	14	88.5	47				1	
TOTAL	71	43	105	149	32	260.5	64				1	1

Appendix 4, (continued)

AREA 3 BOAT 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	5										
Wk-end Days	3	7	37	37		12					12
August											
Wk Days	5	24	97.5	97.5		46		1 adipose 2 L.V.	18	20	8
Wk-end Days	4	24	108.0	108.0		65			37	1	24
September											
Wk Days	6	47	193.0	193.0		83		2 R.V.	64		16
Wk-end Days	3	18	48.5	48.5		30			25		5
October											
Wk Days	6	3	15	15		8				4	4
Wk-end Days	3	2	10	10		7					7
TOTALS											
Wk Days	22	74	305.5	305.5		137		5	82	24	28
Wk-end Days	13	51	203.5	203.5		114			62	1	48
TOTAL	35	125	509.0	509.0		251		5	144	25	76

Appendix 4, (continued)

AREA 3 BOAT 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days												
Wk-end Days				7	12	37	8					
August												
Wk Days	5	11	28.5	2	4	28	6	1				
Wk-end Days	1	6	1	6	5	8	3		1			1
September												
Wk Days	4	9	24	2	8	10	8	1				1
Wk-end Days							7					
October												
Wk Days												
Wk-end Days	2	7	10									
TOTALS												
Wk Days	9	20	52.5	4	12	38	14	2				1
Wk-end Days	3	13	11.0	13	17	45	18		1			1
TOTAL	12	33	63.5	17	29	83	32	2	1			2

Appendix 4, (continued)

AREA 4 BANK 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	6	83	159.5	152.5	7	22		1 L.V.	1	17	4
Wk-end Days	3	50	103.5	99.5	4	31	1		9	20	3
August											
Wk Days	8	141	287.5	241.5	46	46	3	2 L.V.	31	12	6
Wk-end Days	1	7	14.5	10.5	4		2			2	
September											
Wk Days	6	63	131.5	87.5	45	31	13		29	15	
Wk-end Days	3	22	43	36	7	8		1 L.V.	5	1	2
October											
Wk Days	5	16	33	20.5	12.5	3	1		4		
Wk-end Days	3	9	15.5	2	13.5		1				1
TOTALS											
Wk Days	25	303	611.5	502	110.5	102	17	3	65	44	10
Wk-end Days	10	88	176.5	148	28.5	39	4	1	14	23	6
TOTAL	35	391	788.0	650	139.0	141	21	4	79	67	16

Appendix 4, (continued)

AREA 4 BANK 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	11	4	27.5	67	18	128	32					
Wk-end Days	22	9	31.5	28	7	72	38		1			
August												
Wk Days	19	4		24.5	44	225.5	40	1	2			
Wk-end Days	3		8	4	2	6.5						
September												
Wk Days	9	17	24	54	27	106.5	30		1		1	
Wk-end Days	5	3	10.5	17	5	32.5	2					
October												
Wk Days	5	1	18	11	3	15						
Wk-end Days	4		6	5	1	9.5	1					
TOTALS												
Wk Days	44	26	69.5	156.5	92	475	102	1	3		1	
Wk-end Days	34	12	56	54	15	120.5	41		1			
TOTAL	78	38	125.5	210.5	107	595.5	143	1	4		1	

Appendix 4, (continued)

AREA 4 BOAT 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	5	26	135	135		62					
Wk-end Days	3	24	130	130		31			5	80	18
August											
Wk Days	4	26	147	147		39		1 adipose	5	8	24
Wk-end Days	5	44	216	216		87		1 L.V.	19	19	51
September											
Wk Days	6	30	125.5	125.5		86		1 L.V. 1 R.V.	47		39
Wk-end Days	3	29	106.5	106.5		82		1 L.V. 1 R.V.	60	2	20
October											
Wk Days	7	9	27	27		25			18		7
Wk-end Days	3	23	75.5	75.5		53		2 L.V. 2 R.V.	35	13	5
TOTALS											
Wk Days	22	91	434.5	434.5		212		3	70	8	70
Wk-end Days	14	120	528	528		253		7	119	114	94
TOTAL	36	211	962.5	962.5		465		10	189	122	164

Appendix 4, (continued)

AREA 4 BOAT 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days												
Wk-end Days	2	1	10	18	63	110	13		1			
August												
Wk Days				10	16	57	2					
Wk-end Days	6	15	27	19	30	90	8	1	1			
September												
Wk Days				2	6	6	8		1			
Wk-end Days	11	19	53				3		1			
October												
Wk Days												
Wk-end Days	4	12	15									
TOTALS												
Wk Days				12	22	63	10		1			
Wk-end Days	23	47	105	37	93	200	24	1	3			
TOTAL	23	47	105	49	115	263	34	1	4			

Appendix 4, (continued)

AREA 5 BANK 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	6	45	49	16	32	6	26	1 L.V.	3	25	4
Wk-end Days	3	20	25	16	9	7	5		1	7	4
August											
Wk Days	6	44	58.5	35	23.5	17	4		10	11	
Wk-end Days	1	10	14	5	9		6		6		
September											
Wk Days	4	33	50	31.5	18.5	18	7		10	14	1
Wk-end Days	3	19	34	15.5	18.5	1	2		1	1	1
October											
Wk Days	5	5	13	4	9	2	12		12	2	
Wk-end Days	3	4	7.5	5	2.5	4	1		5		
TOTALS											
Wk Days	21	127	170.5	86.5	83	43	49	1 L.V.	35	52	5
Wk-end Days	10	53	80.5	41.5	39	12	14		13	8	5
TOTAL	31	180	251.0	128.0	122	55	63	1 L.V.	48	60	10

Appendix 4, (continued)

AREA 5 BANK 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb	Brk	Brn	Mck	Hyb
July												
Wk Days	17	19	19.5	28	13	13	12					
Wk-end Days	12	5	12	8	7	29.5	4					
August												
Wk Days	5	2	6	39	19	39.5	1					
Wk-end Days	8	3	11.5	2	3	2.5						
September												
Wk Days	7	8	8.5	26	17	41.5	8					
Wk-end Days	4	1	3.5	15	2	30.5	2					
October												
Wk Days	5	14	13									
Wk-end Days	3	5	7	1		0.5		1				
TOTALS												
Wk Days	34	43	47	93	49	94	21					
Wk-end Days	27	14	34	26	12	63	6	1				
TOTAL	61	57	81	119	61	157	27	1				

Appendix 4, (continued)

AREA 5 BOAT 1970	No. Days	No. FMN	FMN Hrs.	Thru Hrs.	Not Thru Hrs.	Cutt. Harvest Thru	Cutt. Harvest Not Thru	Cutt. Mark Returns	Harvest Methods Flies	Bait	Lures
July											
Wk Days	6	6	36	36		18				18	
Wk-end Days	3	4	19	19		17				17	
August											
Wk Days	8	36	226	226		77		3 L.V.	5	57	15
Wk-end Days	1	12	64	64		26			2	18	6
September											
Wk Days	6	47	144	144		51		1 L.V.	28	8	15
Wk-end Days	3										
October											
Wk Days	6										
Wk-end Days	3										
TOTALS											
Wk Days	26	89	406	406		146		4	33	83	30
Wk-end Days	10	16	83	83		43			2	35	6
TOTAL	36	105	489	489		189		4	35	118	36

Appendix 4, (continued)

AREA 5 BOAT 1970	No. Res. FMN	Resident Catch Cutt.	Hrs.	No. Non-Res. FMN	Non-Res. Catch Cutt.	Hrs.	Non Trout Species	Other Game Species Rb Brk Brn Mck Hyb
July								
Wk Days	2			4			6	
Wk-end Days	2		1	2			1	
August								
Wk Days	5	12	22	1		1	9	
Wk-end Days	8	24	40				3	
September								
Wk Days	3	4	9	18	17	46	5	
Wk-end Days								
October								
Wk Days								
Wk-end Days								
TOTALS								
Wk Days	10	16	31	23	17	47	20	
Wk-end Days	10	24	41	2			4	
TOTAL	20	40	72	25	17	47	24	

Appendix 5. An example of stratified harvest estimates, Section 4, 1969.

Total Cutts.	n_h	$\bar{y}_h$	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
July									
Bank 16	4	4.00	6.67	0.126	0.015876	0.003969	0.504065	0.840420	0.026473
Boat 37	4	9.25	114.25	0.126	0.015876	0.003969	1.165650	14.395500	0.453458
Aug									
Bank 14	5	2.80	9.70	0.126	0.015876	0.003175	0.352845	1.222200	0.030799
Boat 125	4	31.25	482.25	0.126	0.015876	0.003969	3.938008	60.763500	1.914050
Sept									
Bank 9	4	2.25	3.58	0.122	0.014884	0.003721	0.274390	0.436760	0.013321
Boat 7	3	2.33	16.33	0.122	0.014884	0.004961	0.284146	1.992260	0.081019
Oct									
Bank 11	4	2.75	6.25	0.126	0.015876	0.003969	0.346544	0.787500	0.024806
Boat 17	4	4.25	37.58	0.126	0.015876	0.003969	0.535569	4.735080	0.149155
Total							7.401217	85.173220	2.693081

Population of N units = $N_1 + N_2 + \ldots\ldots N_L = N$

N = (2[# strata in July])(31[# days in July])(2)(31) + (2)(30) + (2)(31) =

246

Appendix 5, (continued)

Variance Calculations

$$V(\bar{y}_{st})$$

$$s^2(\bar{y}_{st}) = \left[\sum_{h=1}^{L} (W_h{}^2 s_h{}^2)\right] - \frac{1}{N}\left[\sum_{h=1}^{L} (W_h s_h{}^2)\right]$$

$$s^2(\bar{y}_{st}) = 2.693081 - \frac{1}{246}\ (85.173220)$$

$$= 2.693081 - 0.346232$$

$$= \underline{\underline{2.346849}}$$

$$\bar{y}_{st} = \sum_{h=1}^{L} \frac{N_h \bar{y}_h}{N} = 7.401217 \text{ (From column B)}$$

C.I. 95% level

$$N\bar{y}_{st} \pm [t]N\sqrt{s^2(\bar{y}_{st})} = (246)(7.401217) \pm 1.96(246)\sqrt{2.346849}$$

$$= 1820.699 \pm 738.641154$$

or 1821 ± 739

1969 Area 4 Harvest Estimate = 1821 Upper limit 2560

Lower limit 1082

A.M. Corrected Harvest Estimate = 1842 ± 739

Appendix 5, (continued)

SYMBOLS USED IN STRATIFIED ESTIMATES*

N_h ----------total number of units

n_h ----------number of units in sample

y_{hi} ---------value obtained for the ith unit

s_h^2 ---------variance of sample

W_h ----------stratum weight

$\bar{y}_{st}$ ---------the unbiased, weighted estimate of the true mean

$V(\bar{y}_{st})$ ------unbiased estimate of the variance of $\bar{y}_{st}$

*From Sampling Techniques, by Cochran (1963), Chapter 5.

Appendix 6. Daily discharge, in second-feet of the Snake River above Reservoir near Alpine, Wyoming, April - October, 1969.

Date	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
1	1,870	8,090	10,800	7,430	5,170	4,130	2,750
2	2,020	7,500	9,800	7,300	5,260	4,110	2,500
3	2,120	8,010	9,490	7,540	5,240	4,110	2,300
4	2,120	8,800	9,690	7,810	5,240	4,070	2,150
5	2,260	10,000	10,600	7,650	5,120	4,000	2,000
6	2,430	10,800	11,000	6,970	4,950	3,980	1,970
7	2,470	11,200	11,400	6,890	4,980	3,980	1,910
8	2,570	12,000	11,700	6,600	4,840	3,980	1,790
9	3,220	13,000	11,600	6,420	4,720	3,980	1,760
10	4,090	14,000	10,800	6,440	4,700	3,980	1,740
11	5,000	14,800	10,600	6,400	4,630	4,030	1,720
12	5,140	15,000	10,100	6,420	4,950	4,070	1,680
13	5,530	15,000	10,400	6,420	5,050	4,030	1,610
14	5,970	14,800	11,000	6,420	5,100	3,980	1,570
15	6,120	14,500	9,890	6,920	5,050	3,940	1,560
16	5,940	13,600	9,130	7,030	4,950	3,960	1,560
17	6,070	12,700	8,480	6,950	4,790	3,940	1,580
18	6,420	13,200	8,120	6,700	4,790	3,940	1,630
19	6,340	14,000	8,090	6,570	4,750	3,940	1,600
20	6,650	14,500	8,400	6,340	4,610	4,100	1,560
21	7,110	14,400	9,180	6,170	4,500	4,400	1,520
22	7,870	13,800	10,600	6,100	4,410	4,300	1,500
23	9,350	13,500	10,000	6,020	4,320	4,100	1,500
24	9,970	13,600	9,130	5,870	4,260	4,000	1,500
25	9,290	14,200	9,240	5,770	4,320	3,950	1,540
26	8,370	14,700	9,830	5,740	4,340	3,920	1,510
27	7,760	15,100	9,070	5,700	4,110	3,850	1,490
28	7,730	15,300	8,150	5,600	4,190	3,600	1,530

Appendix 6, (continued)

Date	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
29	7,980	13,900	8,090	5,580	4,240	3,350	1,520
30	8,150	12,700	7,570	5,460	4,170	3,000	1,470
31		12,200		5,340	4,130		1,460
TOTAL	167,930	398,900	291,950	200,570	145,880	118,720	53,480
MEAN	5,598	12,870	9,732	6,470	4,706	3,957	1,725

Appendix 7. Daily discharge, in second-feet of the Snake River above Reservoir near Alpine, Wyoming, April - October, 1970.

Date	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
1	1,400	2,790	13,000	13,700	6,070	4,430	4,390
2	1,450	2,900	13,600	11,000	5,880	4,410	4,060
3	1,450	3,300	15,000	11,200	5,710	4,390	3,750
4	1,420	3,740	16,800	11,800	5,610	4,280	3,560
5	1,440	4,680	18,200	12,200	5,520	4,390	3,410
6	1,530	5,310	18,400	11,800	5,520	4,660	3,330
7	1,680	5,970	17,600	11,500	5,380	4,870	3,080
8	1,680	6,070	17,400	10,800	5,270	4,720	2,810
9	1,670	5,670	18,300	10,200	5,290	4,620	2,600
10	1,770	5,740	19,100	9,650	5,090	4,560	2,510
11	2,000	5,140	17,300	9,350	5,020	4,450	2,400
12	1,920	5,240	15,900	9,110	4,870	4,430	2,360
13	1,800	5,260	14,200	8,860	4,810	4,450	2,350
14	1,770	5,190	13,500	8,520	4,760	4,430	2,280
15	1,720	5,340	13,300	8,110	4,720	4,390	2,200
16	1,630	6,400	12,300	7,700	4,680	4,450	2,150
17	1,630	8,230	11,600	7,520	4,640	4,510	2,120
18	1,660	10,400	11,600	7,460	4,530	4,510	2,110
19	1,720	11,400	12,400	7,330	4,470	4,510	2,090
20	1,680	12,100	13,900	7,200	4,490	4,510	2,080
21	1,850	12,800	15,200	6,990	4,450	4,580	2,080
22	2,120	12,600	16,400	7,040	4,410	4,600	2,090
23	2,220	12,800	17,200	6,780	4,370	4,580	2,080
24	2,260	11,900	17,900	6,520	4,300	4,560	2,130
25	2,260	11,100	17,900	6,320	4,320	4,530	2,120
26	2,400	12,100	18,100	6,240	4,260	4,490	2,060
27	2,490	13,300	17,700	6,240	4,260	4,490	1,970

Appendix 7, (continued)

Date	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
28	2,670	14,900	18,500	6,170	4,450	4,470	1,930
29	2,790	13,500	18,500	6,420	4,530	4,430	1,950
30	2,780	13,500	16,700	6,400	4,430	4,410	1,930
31		13,500		6,320	4,370		1,890
TOTAL	56,870	262,870	477,500	266,450	150,480	135,110	77,870
MEAN	1,896	8,480	15,917	8,595	4,854	4,504	2,512

Appendix 8. Confidence interval calculations for the Section 4 population estimate, Snake River, 1969.

$$95\%\ C.I. = \frac{\sum (M_{(t)} \cdot C_{(t)})}{\left[\left(\sum R_t\right)+1 \pm 2.093\right]\sqrt{\sum R_{(t)}}}$$

$$= \frac{60033}{15 \pm 2.093\sqrt{14}} = \frac{60033}{15 \pm 2.093(3.7416)}$$

$$= \frac{60033}{15 \pm 7,832}$$

$$\text{Lower C.I.} = \frac{60033}{15+7.832} = \frac{60033}{22.832} = 2629.34$$

$$\text{Upper C.I.} = \frac{60033}{15-7.832} = \frac{60033}{7.168} = 8375.14$$

$$\hat{N} = \underline{\underline{4002}}$$

upper limit = 8375

lower limit = 2629

Appendix 9. Confidence interval calculations for the Section 4 population estimate, Snake River, 1970.

$$95\%\ C.I. = \frac{\Sigma(M_{(t)} \cdot C_{(t)})}{\left[(\Sigma R_t)+1\right] \pm 2.011\sqrt{\Sigma R_{(t)}}}$$

$$= \frac{138864}{14 \pm 2.011\sqrt{13}} \qquad = \frac{138864}{14 \pm 2.011(3.6055)}$$

$$= \frac{138864}{14 \pm 7.2507}$$

$$\text{Lower C.I.} = \frac{138864}{14+7.2507} = \frac{138864}{21.2507} = 6{,}534.56$$

$$\text{Upper C.I.} = \frac{138864}{14-7.2507} = \frac{138864}{6.7493} = 20{,}574.58$$

upper limit = 20,575

$\hat{N} = \underline{9{,}919}$

lower limit = 6,535

Appendix 10. Snake River cutthroat harvest conversion data.

A. Conversions for 1967 estimates.
   1. Subtract Section 6 data for comparison to 1969 and 1970 data.
   2. Reduce 1967 data, Sections 3 through 5, for comparison to 1969 and 1970 data.
      24.65 percent of all bank fishermen fished during April through June.
      8.55 percent of all boat fishermen fished during April through June.
      27.64 percent of all bank hours occurred during April through June.
      10.41 percent of all boat hours occurred during April through June.
      25.14 percent of all bank harvested cutthroat trout were caught during April through June.
      8.19 percent of all boat harvested cutthroat trout were caught during April through June.
   3. Reduce 1967 data depicting harvest as total trout, to obtain estimates of cutthroat trout harvested in each study section.
      a. In Section 1, 89 percent were cutthroat trout.
      b. In Section 2, 98.6 percent were cutthroat trout.
      c. In Section 3, 94.2 percent were cutthroat trout.
      d. In Section 4, 97.6 percent were cutthroat trout.
      e. In Section 5, 100 percent were cutthroat trout.

B. Conversions for 1968 estimates.
   1. Subtract Section 6 data for comparison to 1969 and 1970 data.
   2. Reduce 1968 data, Sections 3 through 5, for comparison to 1969 and 1970 data.
      34.54 percent of all bank fishermen fished during April through June.
      16.64 percent of all boat fishermen fished during April through June.
      33.58 percent of all bank hours occurred during April through June.
      11.46 percent of all boat hours occurred during April through June.
      24.71 percent of all bank harvested cutthroat trout were caught during April through June.

Appendix 10, (continued)

7.36 percent of all boat harvested cutthroat trout were caught during April through June.

C. Conversion factors for A.M. fishermen, hours fished, and cutthroat trout harvested from combined 1967 and 1968 data.

1.56 percent of all fishermen fished during the A.M. period.

1.13 percent of all hours fished were during the A.M. period.

1.19 percent of all cutthroat were harvested during the A.M. period.

Appendix II. Stratified harvest estimate and 95 percent C.I. determination, 1969.

	Total Cutts.	n_h	$\bar{y}_h$	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
APRIL										
Area 1										
Bank	2	3	0.67	1.33	0.020	0.000400	0.000133	0.0134	0.027	0.009000
Boat	0	2	0	0	0.020	0.000400	0.000200	0.0000	0.000	0.000000
Area 2										
Bank	0	3	0	0	0.020	0.000400	0.000133	0.0000	0.000	0.000000
Boat	0	4	0	0	0.020	0.000400	0.000100	0.0000	0.000	0.000000
MAY										
Area 1										
Bank	5	4	1.25	2.25	0.021	0.000441	0.000110	0.0257	0.047	0.011750
Boat	0	3	0	0	0.021	0.000441	0.000147	0.0000	0.000	0.000000
Area 2										
Bank	0	1	0	0	0.021	0.000441	0.000441	0.0000	0.000	0.000000
JUNE										
Area 1										
Bank	5	4	1.25	2.25	0.020	0.000400	0.000100	0.0249	0.045	0.011250
Boat	0	2	0	0	0.020	0.000400	0.000200	0.0000	0.000	0.000000
JULY										
Area 1										
Bank	12	4	3.00	28.67	0.021	0.000441	0.000110	0.0618	0.602	0.150500
Boat	0	2	0	0	0.021	0.000441	0.000220	0.0000	0.000	0.000000
Area 2										
Bank	5	3	1.67	8.33	0.021	0.000441	0.000147	0.0344	0.175	0.058333
Boat	32	4	8.00	66.00	0.021	0.000441	0.000110	0.1650	1.386	0.346500

Appendix II, (continued)

	Total Cutts.	n_h	$\bar{y}_h$	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
Area 3										
Bank	9	4	2.25	2.92	0.021	0.000441	0.000110	0.0464	0.061	0.015250
Boat	35	4	11.25	112.25	0.021	0.000441	0.000110	0.2320	2.357	0.589250
Area 4										
Bank	16	4	4.00	6.67	0.021	0.000441	0.000110	0.0825	0.140	0.035000
Boat	37	4	9.25	114.25	0.021	0.000441	0.000110	0.1907	2.399	0.599750
Area 5										
Bank	6	4	1.50	3.00	0.021	0.000441	0.000110	0.0309	0.063	0.015750
Boat	24	4	6.00	144.00	0.021	0.000441	0.000110	0.1237	3.024	0.756000
August										
Area 1										
Bank	8	4	2.00	2.67	0.021	0.000441	0.000110	0.0413	0.056	0.014000
Boat	1	4	0.25	0.25	0.021	0.000441	0.000110	0.0051	0.005	0.001250
Area 2										
Bank	1	3	0.33	0.33	0.021	0.000441	0.000147	0.0068	0.007	0.002333
Boat	27	4	6.75	34.25	0.021	0.000441	0.000110	0.1392	0.719	0.179750
Area 3										
Bank	20	4	5.00	20.67	0.021	0.000441	0.000110	0.1031	0.434	0.108500
Boat	15	4	3.75	38.92	0.021	0.000441	0.000110	0.0773	0.817	0.204250

Appendix II, (continued)

	Total Cutts.	n_h	$\bar{y}_h$	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
Area 4										
Bank	14	5	2.80	9.70	0.021	0.000441	0.000088	0.0577	0.204	0.040800
Boat	125	4	31.25	482.25	0.021	0.000441	0.000110	0.6445	10.127	2.531750
Area 5										
Bank	30	5	6.00	41.00	0.021	0.000441	0.000088	0.1237	0.861	0.172200
Boat	39	4	9.75	4.92	0.021	0.000441	0.000110	0.2010	0.103	0.025750
SEPTEMBER										
Area 1										
Bank	4	3	1.33	0.33	0.020	0.000400	0.000133	0.0265	0.007	0.002333
Boat	18	4	4.50	81.00	0.020	0.000400	0.000100	0.0898	1.620	0.405000
Area 2										
Bank	18	4	4.50	29.67	0.020	0.000400	0.000100	0.0898	0.593	0.148250
Boat	17	4	4.25	24.25	0.020	0.000400	0.000100	0.0848	0.485	0.121250
Area 3										
Bank	2	3	0.67	1.33	0.020	0.000400	0.000133	0.0133	0.027	0.009000
Boat	20	4	5.00	40.67	0.020	0.000400	0.000100	0.0998	0.813	0.203250
Area 4										
Bank	9	4	2.25	3.58	0.020	0.000400	0.000100	0.0449	0.072	0.018000
Boat	7	3	2.33	16.33	0.020	0.000400	0.000133	0.0465	0.327	0.109000

Appendix II, (continued)

	Total Cutts.	n_h	$\bar{y}_h$	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
Area 5										
Bank	30	4	7.50	59.67	0.020	0.000400	0.000100	0.1497	1.193	0.298250
Boat	10	4	2.50	25.00	0.020	0.000400	0.000100	0.0499	0.500	0.125000
OCTOBER										
Area 1										
Bank	2	3	0.67	1.33	0.021	0.000441	0.000147	0.0138	0.028	0.009300
Boat	0	3	0	0	0.021	0.000441	0.000147	0.0000	0.000	0.000000
Area 2										
Bank	3	4	0.75	2.25	0.021	0.000441	0.000110	0.0154	0.047	0.011825
Boat	0	2	0	0	0.021	0.000441	0.000220	0.0000	0.000	0.000000
Area 3										
Bank	6	3	2.00	12.00	0.021	0.000441	0.000147	0.0412	0.252	0.084000
Boat	9	5	1.80	16.00	0.021	0.000441	0.000088	0.0371	0.340	0.068040
Area 4										
Bank	11	4	2.75	6.25	0.021	0.000441	0.000110	0.0567	0.131	0.032825
Boat	17	4	4.25	37.58	0.021	0.000441	0.000110	0.0876	0.789	0.197300
Area 5										
Bank	1	5	0.20	0.20	0.021	0.000441	0.000088	0.0041	0.004	0.000840
Boat	0	3	0	0.	0.021	0.000441	0.000147	0.0000	0.000	0.000000

Population of N units = $N_1+N_2+.....N_L = N$

N = (4, # strata in April)(30, days in April) + (3)(31) + (2)(30) + (10)(31) + (10)(31) + (10)(30) + (10)(31) = 1503

Appendix II, (continued)

Variance Calculations

$$V(\bar{y}_{st})$$

$$s^2(\bar{y}_{st}) = \left[\sum_{h=1}^{L} \frac{(W_h^2 s_h^2)}{n_h} \right] - \frac{1}{N} \left[\sum_{h=1}^{L} (W_h s_h^2) \right]$$

$$s^2(\bar{y}_{st}) = 7.722379 - \frac{1}{1503} \quad (30.887)$$

$$= 7.722379 - 0.020550$$

$$= \underline{\underline{7.701829}}$$

$$\bar{y}_{st} = \sum_{h=1}^{L} \frac{N_h \bar{y}_h}{N} = \underline{\underline{3.3820}} \text{ (from column 8)}$$

C.I. 95% level

$$N\bar{y}_{st} \pm [\, t \,] N \sqrt{s^2(\bar{y}_{st})} = (1503)(3.3820) \pm 1.96(1503) \sqrt{7.701829}$$

$$= 5083 \pm 8176$$

Harvest Estimate = 5083 Upper limit = 13259

Lower limit = 3093

A.M. Corrected Harvest Estimate = 5144 $\pm$ 8176

Appendix 12. Calculated cutthroat harvest (bank and boat), Sections 1 through 5, Snake River, 1969.

AREA 1 BANK

		n	N	c	Censused Cutt. Harvest	Est.Cutt. Harvest
APRIL	Week Days	3	22		2	
	Weekend Days	0	8		0	
		3	30	10.0	2	20
MAY	Week Days	2	22		3	
	Weekend Days	2	9		2	
		4	31	7.750	5	39
JUNE	Week Days	4	21		5	
	Weekend Days	0	9		0	
		4	30	7.500	5	38
JULY	Week Days	4	23		12	
	Weekend Days	0	8		0	
		4	31	7.750	12	93
AUGUST	Week Days	3	21		6	
	Weekend Days	1	10		2	
		4	31	7.750	8	62
SEPTEMBER	Week Days	3	22		4	
	Weekend Days	0	8		0	
		3	30	10.000	4	40
OCTOBER	Week Days	3	23		2	
	Weekend Days	0	8		0	
		3	31	10.333	2	0
						292
					A.M. Correction	295

AREA 1 BOAT

APRIL	Week Days	0	22		0	
	Weekend Days	2	8		0	
		2	30	15.000	0	0

Appendix 12, (continued)

AREA 1 BOAT

		n	N	c	Cutt.Harvest	Est.Cutt. Harvest
MAY	Week Days	3	22		0	
	Weekend Days	1	9		0	
		4	31	7.750	0	0
JUNE	Week Days	2	21		0	
	Weekend Days	0	9		0	
		2	30	15.000	0	0
JULY	Week Days	2	23		0	
	Weekend Days	0	8		0	
		2	31	15.500	0	0
AUGUST	Week Days	3	21		0	
	Weekend Days	1	10		1	
		4	31	7.750	1	8
SEPTEMBER	Week Days	2	22		18	
	Weekend Days	2	8		0	
		4	30	7.500	18	135
OCTOBER	Week Days	2	23		0	
	Weekend Days	1	8		0	
		3	31	10.333	0	0
						143
				A.M. Correction		145

AREA 2 BANK

APRIL	Week Days	3	2		0	
	Weekend Days	0	8		0	
		3	30	10.000	0	0
MAY	Week Days	1	22		0	
	Weekend Days	0	9		0	
		1	31	31.000	0	0

Appendix 12, (continued)

AREA 2 BANK

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
JULY	Week Days	2	23		5	
	Weekend Days	1	8		0	
		3	31	10.333	5	52
AUGUST	Week Days	3	21		1	
	Weekend Days	0	10		0	
		3	31	10.333	1	10
SEPTEMBER	Week Days	4	22		18	
	Weekend Days	0	8		0	
		4	30	7.500	18	135
OCTOBER	Week Days	4	23		3	
	Weekend Days	0	8		0	
		4	31	7.750	3	23
						220
				A.M. Correction		223

AREA 2 BOAT

APRIL	Week Days	3	22		0	
	Weekend Days	0	8		0	
		3	30	10.000	0	0
JULY	Week Days	3	23		21	
	Weekend Days	1	8		11	
		4	31	7.750	32	248
AUGUST	Week Days	3	21		19	
	Weekend Days	1	10		8	
		4	31	7.750	27	209
SEPTEMBER	Week Days	4	22		25	
	Weekend Days	0	8		0	
		4	30	7.500	25	188

Appendix 12, (continued)

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
				AREA 2 BOAT		
October	Week Days	1	23		0	
	Weekend Days	1	8		0	
		2	31	15.500	0	0
						645
				A.M. Correction		653
				AREA 3 BANK		
JULY	Week Days	4	23		9	
	Weekend Days	0	8		0	
		4	31	7.750	9	70
AUGUST	Week Days	3	21		9	
	Weekend Days	1	10		11	
		4	31	7.750	20	155
SEPTEMBER	Week Days	3	22		2	
	Weekend Days	0	8		0	
		3	30	10.000	2	20
OCTOBER	Week Days	2	23		6	
	Weekend Days	1	8		0	
		3	31	10.333	6	62
						307
				A.M. Correction		311
				AREA 3 BOAT		
JULY	Week Days	2	23		28	
	Weekend Days	2	8		17	
		4	31	7.750	45	349

Appendix 12, (continued)

AREA 3 BOAT

		n	N	c	Censused Cutt. Harvest	Est. Cutt. Harvest
AUGUST	Week Days	2	21		2	
	Weekend Days	2	10		13	
		4	31	7.750	15	116
SEPTEMBER	Week Days	3	22		15	
	Weekend Days	1	8		5	
		4	30	7.500	20	150
OCTOBER	Week Days	4	23		0	
	Weekend Days	1	8		9	
		5	31	6.200	9	56
						671
					A.M. Correction	679

AREA 4 BANK

JULY	Week Days	4	23		16	
	Weekend Days	0	8		0	
		4	31	7.750	16	124
AUGUST	Week Days	3	21		7	
	Weekend Days	1	10		7	
		4	31	7.750	14	109
SEPTEMBER	Week Days	3	22		4	
	Weekend Days	1	8		5	
		4	30	7.500	9	68
OCTOBER	Week Days	3	23		8	
	Weekend Days	1	8		3	
		4	31	7.750	11	85
						386
					A.M. Correction	391

pendix 12, (continued)

AREA 4 BOAT

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
LY	Week Days	4	23		37	
	Weekend Days	0	8		0	
		4	31	7.750	37	287
GUST	Week Days	4	21		125	
	Weekend Days	0	10		0	
		4	31	7.750	125	969
PTEMBER	Week Days	2	22		0	
	Weekend Days	1	8		7	
		3	30	10.000	7	70
TOBER	Week Days	4	23		17	
	Weekend Days	0	8		0	
		4	31	7.750	17	132
						1,458
					A.M. Correction	1,475

AREA 5 BANK

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
LY	Week Days	3	23		5	
	Weekend Days	1	8		1	
		4	31	7.750	6	47
GUST	Week Days	3	21		7	
	Weekend Days	2	10		23	
		5	31	6.200	30	186
PTEMBER	Week Days	3	22		28	
	Weekend Days	1	8		2	
		4	30	7.500	30	225
TOBER	Week Days	5	23		1	
	Weekend Days	0	8		0	
		5	31	6.200	1	6
						464
					A.M. Correction	470

Appendix 12, (continued)

AREA 5 BOAT

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
JULY	Week Days	4	23		24	
	Weekend Days	0	8		0	
		4	31	7.750	24	186
AUGUST	Week Days	3	21		28	
	Weekend Days	1	10		11	
		4	31	7.750	39	302
SEPTEMBER	Week Days	3	22		10	
	Weekend Days	1	8		0	
		4	30	7.750	10	75
OCTOBER	Week Days	3	23		0	
	Weekend Days	0	8		0	
		3	31	10.333	0	0
						563
					A.M. Correction	570

Appendix 13. Stratified harvest estimate and 95 percent C.I., Areas 1 and 2, 1970.

	Total Cutts.	n_h	y_h	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
APRIL										
Area 1										
Bank	0	5	0	0	0.047	.002209	.000442	0.0000		
Boat	0	2	0	0	0.047	.002209	.001104	0.0000		
Area 2										
Bank	0	2	0	0	0.047	.002209	.001104	0.0000		
Boat	0	2	0	0	0.047	.002209	.001104	0.0000		
MAY										
Area 1										
Bank	1	4	0.25000	0.25000	0.048	.002304	.000576	0.0120	0.0120	0.000144
Boat	0	2	0	0	0.048	.002304	.001152	0.0000		
Area 2										
Bank	0	2	0	0	0.048	.002304	.001152	0.0000		
Boat	0	2	0	0	0.048	.002304	.001152	0.0000		
JUNE										
Area 1										
Bank	37	7	5.28571	15.23809	0.047	.002209	.000316	0.2473	0.7162	0.004808
Boat	0	6	0	0	0.047	.002209	.000368	0.0000		
JULY										
Area 1										
Bank	15	3	5.00000	3.00000	0.048	.002304	.001768	0.2418	0.1440	0.002304
Boat	0	7	0	0	0.048	.002304	.000329	0.0000		

Appendix 13, (continued)

	Total Cutts.	n_h	y_h	s_h^2	W_h	W_h^2	$\frac{W_h^2 s_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
Area 2										
Boat	9	4	2.25000	8.25000	0.048	.002304	.000576	0.1088	0.3960	0.004752
AUGUST										
Area 1										
Bank	31	3	10.33333	89.33333	0.048	.002304	.000768	0.4997	4.2880	0.068608
Boat	0	1	0	0	0.048	.002304	.002304	0.0000		
Area 2										
Bank	15	5	3.00000	16.50000	0.048	.002304	.000461	0.1450	0.7920	0.007603
Boat	43	5	8.60000	16.30000	0.048	.002304	.000461	0.4159	0.7824	0.007511
SEPT										
Area 1										
Bank	18	2	9.00000	50.00000	0.047	.002209	.001105	0.4212	2.3500	0.055225
Boat	6	2	3.00000	18.00000	0.047	.002209	.001105	0.1404	0.8460	0.019881
Area 2										
Bank	1	2	0.50000	0.50000	0.047	.002209	.001105	0.0234	0.0235	0.000552
Boat	0	2	0	0	0.047	.002209	.001105	0.0000		
				217.371420	0.998000		0.019557	2.2555	10.3501	0.171388

Appendix 13, (continued)

Variance Calculations

$$V(\bar{y}_{st})$$

$$s^2(\bar{y}_{st}) = \left[\sum_{h=1}^{L} \frac{(W_h{}^2 s_h{}^2)}{n_h}\right] - \frac{1}{N}\left[\sum_{h=1}^{L} (W_h s_h{}^2)\right]$$

$$s^2(\bar{y}_{st}) = 0.171388 - \frac{1}{641} \quad (10.3501)$$

$$= 0.171388 - 0.016146$$

$$= \underline{\underline{0.155242}}$$

$$\bar{y}_{st} = \sum_{h=1}^{L} \frac{N_h \bar{y}_h}{N} = 2.2555$$

C.I. 95% level

$$N\bar{y}_{st} \pm [t]\ N \sqrt{s^2(\bar{y}_{st})} = (641)(2.2555) \pm 1.96(641)\sqrt{0.155242}$$

$$= 1446 \pm 495$$

1970 Areas 1 and 2 Harvest Estimate = 1446 Upper limit = 1941

Lower limit = 951

A.M. Corrected Harvest Estimate = 1453 ± 495

Appendix 14. Stratified harvest estimate and 95 percent C.I., Areas 3 through 5, 1970.

	Total Cutts.	n_h	y_h	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
JULY										
Area 3										
Bank	30	9	3.33	8.00	0.042	.001764	.000196	0.1400	.3360	.001568
Boat	12	8	1.50	18.00	0.042	.001764	.000221	0.0630	.7560	.003978
Area 4										
Bank	54	9	6.00	32.00	0.042	.001764	.000196	0.2520	1.3440	.006272
Boat	93	8	11.63	227.98	0.042	.001764	.000221	0.4883	9.5752	.050384
Area 5										
Bank	44	9	4.89	16.11	0.042	.001764	.000196	0.2053	0.6766	.003158
Boat	35	9	3.89	59.61	0.042	.001764	.000196	0.1633	2.5036	.011684
AUGUST										
Area 3										
Bank	18	9	2.00	2.00	0.042	.001764	.000196	0.0840	.0840	.000392
Boat	111	9	12.33	182.50	0.042	.001764	.000196	0.5180	7.6650	.035770
Area 4										
Bank	51	9	5.67	31.25	0.042	.001764	.000196	0.2380	1.3125	.006125
Boat	126	9	14.00	64.50	0.042	.001764	.000196	0.6020	2.7090	.012642
Area 5										
Bank	27	7	3.86	3.48	0.042	.001764	.000252	0.1620	.1462	.000877
Boat	103	9	11.44	119.53	0.042	.001764	.000196	0.4807	5.0203	.023428

Appendix 14, (continued)

	Total Cutts.	n_h	y_h	s_h^2	W_h	W_h^2	$\frac{W_h^2}{n_h}$	$\frac{N_h \bar{y}_h}{N}$	$W_h s_h^2$	$\frac{W_h^2 s_h^2}{n_h}$
SEPT										
Area 3										
Bank	19	7	2.71	11.91	0.041	.001681	.000240	0.1103	.4883	.002858
Boat	113	9	12.56	146.28	0.041	.001681	.000187	0.5103	5.9975	.027354
Area 4										
Bank	52	9	5.78	38.69	0.041	.001681	.000187	0.2348	1.5862	.007235
Boat	168	9	18.67	170.00	0.041	.001681	.000187	0.7588	6.9700	.031790
Area 5										
Bank	28	7	4.00	34.67	0.041	.001681	.000240	0.1626	1.4215	.008320
Boat	51	9	5.67	72.25	0.041	.001681	.000187	0.2303	2.9623	.013511
OCTOBER										
Area 3										
Bank	8	9	0.89	1.61	0.042	.001764	.000196	0.0373	.0676	.000316
Boat	15	9	1.67	11.00	0.042	.001764	.000196	0.0700	.4620	.002156
Area 4										
Bank	5	8	0.63	1.98	0.042	.001764	.000221	0.0262	.0832	.000438
Boat	78	10	7.80	134.40	0.042	.001764	.001764	0.3276	5.6448	.237082
Area 5										
Bank	19	8	2.38	8.27	0.042	.001764	.000221	0.0997	.3473	.001827
Boat	0	9	0	0	0.042	.001764	.000196	0.0000	.0000	.000000
				1396.02	1.002		.006480	5.9512	58.9079	.489165

Appendix 14, (continued)

Variance Calculations

$$V(\bar{y}_{st})$$

$$s^2(\bar{y}_{st}) = \left[\sum_{h=1}^{L} (W_h{}^2 s_h{}^2)\right] - \frac{1}{N}\left[\sum_{h=1}^{L} (W_h s_h{}^2)\right]$$

$$s^2(\bar{y}_{st}) = .489165 - \frac{1}{738}(58.9079)$$

$$= .489165 - .079821$$

$$= \underline{\underline{0.409344}}$$

$$\bar{y}_{st} = \sum_{h=1}^{L} \frac{N_h \bar{y}_h}{N} = 5.9512$$

C.I. 95% level

$$N\bar{y}_{st} \pm [t]\, N \sqrt{s^2(\bar{y}_{st})} = (738)(5.9512) \pm 1.96(738)\sqrt{0.409344}$$

1970 Areas 3 through 5 Harvest Estimate = 4392 $\pm$ 925

Upper limit = 5317

Lower limit = 3467

A.M. Corrected Harvest Estimate = 4444

Appendix 15. Calculated cutthroat harvest (bank and boat), Sections 1 through 5, Snake River, 1970.

AREA 1 BANK

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
APRIL	Week Days	3	22		0	
	Weekend Days	2	8		0	
		5	30	6.000	0	0
MAY	Week Days	3	21		1	
	Weekend Days	1	10		0	
		4	21	7.750	1	8
JUNE	Week Days	4	22		17	
	Weekend Days	3	8		20	
		7	30	4.286	37	159
JULY	Week Days	2	23		9	
	Weekend Days	1	8		6	
		3	31	10.333	15	155
AUGUST	Week Days	1	21		3	
	Weekend Days	2	10		28	
		3	31	10.333	31	320
SEPTEMBER	Week Days	1	22		4	
	Weekend Days	1	8		14	
		2	30	15.000	18	270
						912
				A.M. Correction		923

AREA 1 BOAT

APRIL	Week Days	1	22		0	
	Weekend Days	1	8		0	
		2	30	15.000	0	0
MAY	Week Days	2	21		0	
	Weekend Days	0	10		0	
		2	31	15.500	0	0

Appendix 15, (continued)

AREA 1 BOAT

		n	N	c	Censused Cutt.	Harvest	Est.Cutt. Harvest
JUNE	Week Days	4	22			0	
	Weekend Days	2	8			0	
		6	30	5.000		0	0
JULY	Week Days	4	23			0	
	Weekend Days	3	8			0	
		7	31	4.429		0	0
AUGUST	Week Days	0	21			0	
	Weekend Days	1	10			0	
		1	31	31.000		0	0
SEPTEMBER	Week Days	1	22			0	
	Weekend Days	1	8			6	
		2	30	15.000		6	0
							90
					A.M. Correction		91

AREA 2 BANK

APRIL	Week Days	1	22			0	
	Weekend Days	1	8			0	
		2	30	15.000		0	0
MAY	Week Days	2	21			0	
	Weekend Days	0	10			0	
		2	31	15.000		0	0
AUGUST	Week Days	3	21			13	
	Weekend Days	2	10			2	
		5	31	6.200		15	93

Appendix 15, (continued)

AREA 2 BANK

		n	N	c	Censused Cutt. Harvest	Est. Cutt. Harvest
SEPTEMBER	Week Days	2	22		1	
	Weekend Days	0	8		0	
		2	30	15.000	1	15
						108
					A.M. Correction	109

AREA 2 BOAT

		n	N	c	Censused Cutt. Harvest	Est. Cutt. Harvest
APRIL	Week Days	2	22		0	
	Weekend Days	0	8		0	
		2	30	15.000	0	0
MAY	Week Days	1	21		0	
	Weekend Days	1	10		0	
		2	31	15.000	0	0
JULY	Week Days	2	23		3	
	Weekend Days	2	8		6	
		4	31	7.750	9	70
AUGUST	Week Days	3	21		24	
	Weekend Days	2	10		19	
		5	31	6.200	43	267
SEPTEMBER	Week Days	1	22		0	
	Weekend Days	1	8		0	
		2	30	15.000		0
						337
					A.M. Correction	341

Appendix 15, (continued)

AREA 3 BANK

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
JULY	Week Days	5	23		15	
	Weekend Days	4	8		15	
		9	31	3.44	30	103
AUGUST	Week Days	6	21		10	
	Weekend Days	3	10		8	
		9	31	3.44	18	62
SEPTEMBER	Week Days	4	22		13	
	Weekend Days	3	8		6	
		7	30	4.28	19	81
OCTOBER	Week Days	6	22		5	
	Weekend Days	3	9		3	
		9	31	3.44	8	28
						274
					A.M. Correction	277

AREA 3 BOAT

		n	N	c	Censused Cutt.Harvest	Est.Cutt. Harvest
JULY	Week Days	5	23		0	
	Weekend Days	3	8		12	
		8	31	3.87	12	46
AUGUST	Week Days	5	21		46	
	Weekend Days	4	10		65	
		9	31	3.44	111	382
SEPTEMBER	Week Days	6	22		83	
	Weekend Days	3	8		30	
		9	30	3.33	113	376
OCTOBER	Week Days	6	22		8	
	Weekend Days	3	9		7	
		9	31	3.44	15	52
						856
					A.M. Correction	866

Appendix 15, (continued)

AREA 4 BANK

		n	N	c	Censused Cutt. Harvest	Est. Cutt. Harvest
JULY	Week Days	6	23		22	
	Weekend Days	3	8		32	
		9	31	3.44	54	186
AUGUST	Week Days	8	21		49	
	Weekend Days	1	10		2	
		9	31	3.44	51	175
SEPTEMBER	Week Days	6	22		44	
	Weekend Days	3	8		8	
		9	30	3.33	52	173
OCTOBER	Week Days	5	22		4	
	Weekend Days	3	9		1	
		8	31	3.87	5	19
						554
					A.M. Correction	560

AREA 4 BOAT

		n	N	c	Censused Cutt. Harvest	Est. Cutt. Harvest
JULY	Week Days	5	23		62	
	Weekend Days	3	8		31	
		8	31	3.87	93	360
AUGUST	Week Days	4	21		39	
	Weekend Days	5	10		87	
		9	31	3.44	126	433
SEPTEMBER	Week Days	6	22		86	
	Weekend Days	3	8		82	
		9	30	3.33	168	559
OCTOBER	Week Days	7	22		25	
	Weekend Days	3	9		53	
		10	31	3.10	78	242
						1,595
					A.M. Correction	1,614

Appendix 15, (continued)

AREA 5 BANK

		n	N	c	Censused Cutt.	Harvest	Est.Cutt. Harvest
JULY	Week Days	6	23			32	
	Weekend Days	3	8			12	
		9	31	3.44		44	151
AUGUST	Week Days	6	21			21	
	Weekend Days	1	10			6	
		7	31	4.43		27	120
SEPTEMBER	Week Days	4	22			25	
	Weekend Days	3	8			3	
		7	30	4.28		28	120
OCTOBER	Week Days	5	22			14	
	Weekend Days	3	9			5	
		8	31	3.87		19	74
							464
					A.M. Correction		470

AREA 5 BOAT

JULY	Week Days	6	23			18	
	Weekend Days	3	8			17	
		9	31	3.44		35	120
AUGUST	Week Days	8	21			77	
	Weekend Days	1	10			26	
		9	31	3.44		103	354
SEPTEMBER	Week Days	6	22			51	
	Weekend Days	3	8			0	
		9	30	3.33		51	
OCTOBER	Week Days	6	22			0	
	Weekend Days	3	9			0	
		9	31			0	
							645
					A.M. Correction		652

Appendix 16. Harvest data per study section, Snake River, 1967 and 1968.

	1967			1968		
	Bank	Boat	Total	Bank	Boat	Total
Section 1						
Fishermen	7,819	31	7,850	5,666	384	6,050
Hours	16,644	50	16,694	8,612	1,583	10,195
Cutthroat	2,118	103	2,221	1,571	552	2,123
Hours per fisherman	2.13	1.61	2.13	1.52	4.12	1.69
Cutthroat per hour	0.13	2.06	0.13	0.18	0.35	0.21
Section 2						
Fishermen	1,926	828	2,754	1,771	2,021	3,792
Hours	4,393	3,784	8,177	4,648	10,640	15,288
Cutthroat	1,904	987	2,891	1,757	6.658	8,415
Hours per fisherman	2.28	4.57	2.97	2.62	5.27	4.03
Cutthroat per hour	0.43	0.26	0.35	0.38	0.63	0.55
Section 3						
Fishermen	1,953	240	2,193	857	479	1,336
Hours	6.666	930	7,596	1,244	2,966	4,210
Cutthroat	2,320	522	2,842	819	1,847	2,666
Hours per fisherman	3.41	3.88	3.46	1.45	6.19	3.15
Cutthroat per hour	0.35	0.56	0.37	0.66	0.62	0.63
Section 4						
Fishermen	2,072	154	2,226	1,153	244	1,397
Hours	5,426	948	6,374	2,094	1,403	3,497
Cutthroat	1,504	508	2,012	1,293	1,416	2,709
Hours per fisherman	2.62	6.16	2.86	1.82	5.75	2.50
Cutthroat per hour	0.28	0.54	0.32	0.62	1.01	0.78

Appendix 16, (continued)

	1967			1968		
	Bank	Boat	Total	Bank	Boat	Total
Section 5						
Fishermen	787	178	965	1,205	416	1,621
Hours	1,798	664	2,462	1,687	2,378	4,065
Cutthroat	214	342	556	1,604	2,061	3,665
Hours per fisherman	2.29	3.73	2.55	1.40	5.72	2.51
Cutthroat per hour	0.12	0.52	0.23	0.95	0.87	0.90
Totals						
Fishermen	14,557	1,431	15,988	10,652	3,544	14,196
Hours	34,927	6,376	41,303	18,285	18,970	37,255
Cutthroat	8,060	2,462	10,522	7,044	12,534	19,578
Hours per fisherman	2.40	4.46	2.58	1.72	5.35	2.62
Cutthroat per hour	0.23	0.39	0.26	0.39	0.66	0.53

Appendix 17. Harvest data per study section, Snake River, 1969 and 1970.

	1969			1970		
	Bank	Boat	Total	Bank	Boat	Total
Section 1						
Fishermen	2,654	54	2,708	4,358	190	4,548
Hours	3,520	225	3,745	5,898	357	6,252
Cutthroat	295	145	440	923	91	1,014
Hours per fisherman	1.33	4.17	1.38	1.35	1.88	1.38
Cutthroat per hour	0.08	0.64	0.12	0.16	0.26	0.16
Section 2						
Fishermen	597	696	1,293	243	244	487
Hours	1,011	3,722	4,733	429	1,003	1,432
Cutthroat	223	653	876	109	341	450
Hours per fisherman	1.69	5.35	3.66	1.77	4.11	2.94
Cutthroat per hour	0.22	0.18	0.19	0.25	0.34	0.31
Section 3						
Fishermen	513	316	829	818	427	1,245
Hours	764	1,712	2,476	1,332	1,760	3,092
Cutthroat	311	679	990	277	866	1,143
Hours per fisherman	1.49	5.42	2.99	1.63	4.12	2.48
Cutthroat per hour	0.41	0.40	0.40	0.21	0.49	0.37
Section 4						
Fishermen	689	527	1,216	1,368	741	2,109
Hours	1,103	3,109	4,212	2,744	3,404	6,148
Cutthroat	386	1,475	1,861	560	1,614	2,174
Hours per fisherman	1.60	5.90	3.46	2.01	4.59	2.92
Cutthroat per hour	0.35	0.47	0.44	0.20	0.47	0.35

Appendix 17, (continued)

	1969			1970		
	Bank	Boat	Total	Bank	Boat	Total
Section 5						
Fishermen	575	266	841	732	362	1,094
Hours	876	1,036	1,912	1,027	1,686	2,713
Cutthroat	470	570	1,040	470	652	1,122
Hours per fisherman	1.52	3.89	2.27	1.40	4.66	2.48
Cutthroat per hour	0.54	0.55	0.54	0.46	0.39	0.41
Totals						
Fishermen	5,028	1,859	6,887	7,519	1,964	9,483
Hours	7,274	9,804	17,078	11,430	8,210	19,640
Cutthroat	1,685	3,522	5,207	2,339	3,564	5,903
Hours per fisherman	1.45	5.27	2.48	1.52	4.18	2.07
Cutthroat per hour	0.23	0.36	0.31	0.21	0.43	0.30